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Remedial Planning Activities
At Selected Uncontrolled
Hazardous Substance Disposal Sites
In The Zone of Regions VI, VII and VIII

EPA

Environmental Protection Agency

Contract No. 68-W9-0053

SITE INSPECTION PRIORITIZATION

Rico-Argentine
Rico, Colorado

EPA CLOSEOUT COPY

Work Assignment No. 21-8JZZ

OCTOBER 11, 1994

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URS
A PROFESSIONAL SERVICES ORGANIZATION

URS CONSULTANTS, INC.
1099 18TH STREET
SUITE 700
DENVER, COLORADO 80202-1907
TEL: (303) 296-9700

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October 11, 1994

Mr. Robert Heise
Work Assignment Manager
Superfund Remedial Action Branch
Hazardous Waste Management Division
United States Environmental Protection Agency
Region VIII, Mail Code: 8HWM-WAM
999 - 18th Street, Suite 500
Denver, Colorado 80202-2405

**SUBJECT: ARCS VI, VII AND VIII, CONTRACT NO. 68-W9-0053, WA #21-8JZZ
Site Inspection Prioritization (SIP), Rico-Argentine, Rico, Colorado**

Dear Mr. Heise:

Attached please find a copy of the final Site Inspection Prioritization (SIP) for Rico-Argentine, in Rico, Colorado, for your review and approval. While analytical data from previous sampling investigations and from permit enforcement activities have been considered in this SIP, no effort to determine the data quality for rulemaking has been made at this time. The level of effort required for analyses of data from previous investigations is beyond the scope of a generic SIP.

If you have any questions concerning this report, please call me at 296-9700.

Very truly yours,

URS CONSULTANTS, INC.

TF Staible

T. F. Staible
Program Manager

Attachment

cc:	Pat Smith/EPA/Region VIII	with attachment
	Michael V. Carr/URS/Denver	with attachment
	ARCS File/URS/Denver	with attachment

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SITE INSPECTION PRIORITIZATION

Rico-Argentine
Rico, Colorado

U.S. EPA Contract No. 68-W9-0053
Work Assignment No. 21-8JZZ

CERCLIS ID #COD980952519

Prepared By:
Michael V. Carr

URS Consultants, Inc.
1099 18th Street, Suite 700
Denver, CO 80202-1907

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Approved: T F Staible Date: 10 Oct 94
T. F. Staible, Program Manager, URS

Approved: Michael V. Carr Date: 10/7/94
Michael V. Carr, Project Manager, URS

Approved: PSmith Date: 11/16/94
Pat Smith, Site Assessment Manager, EPA

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Robert Heise	Work Assignment Manager, ARCS, EPA Region VIII, WA #21-8JZZ
Pat Smith (3 copies)	Site Assessment Manager, ARCS, EPA Region VIII, WA #21-8JZZ

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Michael V. Carr	Project Manager, ARCS, EPA Region VIII, WA #21-8JZZ
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SITE INSPECTION PRIORITIZATION

Rico-Argentine
Rico, Colorado

TABLE OF CONTENTS

1.0 INTRODUCTION

URS Consultants, Inc. (URS) has been tasked by the U.S. Environmental Protection Agency (EPA) under the Alternative Remedial Contracts Strategy (ARCS) Contract Number 68-W9-0053 to conduct a Site Inspection Prioritization (SIP) (Work Assignment Number 21-8JZZ) for the Rico-Argentine (R-A) site (CERCLIS ID# COD980952519) located north of Rico, Colorado, 81332. Previous work at the site includes an EPA Potential Hazardous Waste Site - Site Inspection Report (Form 2070-13) compiled by State of Colorado, Department of Health (CDH) personnel in June 1984 and a second Form 2070-13 completed by an EPA contractor, Ecology and Environment (E&E), in November 1984. An EPA surface water and sediment sampling effort was conducted by E&E on November 14, 1984 and an Analytical Results Report (ARR) was delivered to the EPA on July 29, 1985. The U.S. Department of the Interior, Bureau of Reclamation (BOR) has conducted surface water and sediment sampling on Silver Creek and the Dolores River several times a year from 1989 through 1993 (Ecology and Environment (E&E) 1985; U.S. Environmental Protection Agency (EPA) 1984a; EPA 1984b; U.S. Department of the Interior, Bureau of Reclamation (BOR) 1994). This SIP was assigned to a URS investigator on April 11, 1994.

2.0 OBJECTIVES

The purpose of this SIP is to review existing data for the A-R site and identify whether data gaps exist with respect to the revised Hazard Ranking System (HRS) at the R-A site, and to provide sufficient documentation for the EPA to determine the human health and environmental impacts posed by the R-A site, thus determining the appropriate future course of action.

The specific objectives of this SIP are to:

- Summarize the previous work at the R-A site;
- Identify, quantify (if possible) and characterize source areas attributable to this site;
- Identify waste availability to each migration pathway;
- Identify whether there is a potential for, or actual impact on, receptor targets; and
- Identify relevant data gaps for each migration pathway.

3.0 BACKGROUND

3.1 SITE LOCATION

The R-A site encompasses approximately 75 acres of settling ponds near the east end of Dolores County in the Rico Mountains in the southwestern corner of Colorado (Figure 1). A total of approximately 2,500 acres of mining operations have been consolidated under one ownership (EPA 1984b). The Rico Mountains are a subsidiary group of peaks on the southwest fringe of the San Juan Mountains (U.S. Geological Survey (USGS) 1974). The legal description for the R-A site is the southeast quarter of Section 25, Township 40 N, Range 11 W. The approximate site coordinates are 37° 42′ 05" North latitude and 108° 01′ 39" West longitude. The site can be reached by proceeding south from Telluride, Colorado on State Highway 145 over Lizard Head Pass to Rico or by proceeding north from Cortez on State Highway 145.

3.2 SITE DESCRIPTION

Site description information included here is taken primarily from EPA; CDH; and State of Colorado, Division of Mines (DOM) file documents. The R-A site is an inactive mining operation located in portions of two drainages, Silver Creek and the Dolores River, above the town of Rico. Silver Creek and the Dolores River have their confluence within the town of Rico (Figures 1 and 2). The underground mine workings are interconnected and the drainage water from the mines is sent to the St. Louis Tunnel Adit where it is discharged into a slaked lime water treatment plant and then a series of 18 settling ponds before discharging into the Dolores River. The R-A complex has had a National Pollutant Elimination Discharge System (NPDES) permit (#CO-0029793) for this discharge system since 1976 but has been frequently in violation of permit standards (U.S. Environmental Protection Agency, Water Management Division (WMD) 1994). The discharge has also been regulated under the Colorado Pollutant Discharge Elimination System (CPDES). The discharge averages approximately 1.1 to 1.5 million gallons per day (MGD) (WMD 1994). The St. Louis Tunnel Adit is approximately three-quarters of a mile to the north of Rico (USGS 1960). Near the St. Louis Tunnel Adit on the Dolores River are also a large, inactive sulfuric acid plant and two cyanide heap leach basins. Approximately one mile northeast up Silver Creek are located another series of tailings piles and settling ponds, the Blaine Tunnel and the Rico-Argentine Mill (Figure 2). The entire Rico area has been heavily mined in the past. The R-A region is primarily Bureau of Land Management (BLM) property located within the San Juan National Forest with surrounding peaks up to 14,000 feet above mean sea level (msl) and summits in the Rico Mountains over 12,000 feet above msl. The town of Rico and the Dolores River settling ponds are at 8,800 feet above msl and the Silver Creek operations at 9,200 feet above msl (USGS 1960).

3.3 SITE HISTORY AND PREVIOUS WORK

The early history of the Rico mining district began with prospecting attempts in 1861. Eight years later, several claims were staked at the confluence of the Dolores River and Silver Creek and the area became known as the Pioneer District. Over the next ten years, several additional claims were staked but mining was intermittent. In 1879, rich oxidized silver ore was discovered on Nigger Baby Hill and a mining settlement established. A few small smelters were built but operations were short-lived. Silver production rose to a temporary peak in 1883 and then fell off over the next three years. In 1887, a prospect shaft on Newman Hill struck the edge of the richest ore body (a blanket-type) ever found in the area and development accelerated. By 1890, the Rio Grande Southern Railroad Company completed a narrow-gauge line into the camp and the all-time peak of silver production was reached in 1893 (USGS 1905; USGS 1974).

By 1895, exploration and production activity showed signs of abating, partly due to the silver panic of 1893 and partially due to exhaustion of the major ore bodies. In 1902, all of the important mines in the district were consolidated under the United Rico Mines Company which began production of base-metal ores. By 1905, the combined values of lead and zinc production exceeded that of silver. Activity in the Pioneer District waxed and waned with the economics of mining during the next several years with World War I temporarily stimulating production followed by a low ebb in 1921 (USGS 1905; USGS 1974). The Rico Argentine Mining Company (RAMC) was started in 1915 with capital from Utah and quickly became a major producer in the district (State of Colorado, Division of Natural resources, Bureau of Mines (BOM) 1915).

Advances in the metallurgical industry, particularly in flotation processes, made Rico's complex sulfide ores more attractive in the mid-1920s. Ores were shipped to custom flotation mills in Salt Lake City until 1926 at which time a 250-ton custom mill was built at Rico by the International Smelting Company, a subsidiary of Anaconda Mining Company. The RAMC, working the south side of Silver Creek, was one of the major producers during this period. Base-metal peak production occurred in 1927, by 1928 the custom mill in Rico had shut down, in 1929 the Depression drove down the economy and by 1932 production had ceased (USGS 1974).

Mining resumed in 1934 and activities fluctuated until 1939 when RAMC finished a 135-ton flotation mill and started steady production (BOM 1939a; BOM 1939b). The RAMC obtained control of most of the mining properties in the district during this time (BOM 1942a; USGS 1974). By 1940, the mill capacity was up to 150 tons (BOM 1940; USGS 1974). In the early 1940s, RAMC began selling pyrite ore to vanadium producers in Utah (BOM 1942b; BOM 1943). The narrow-gauge railroad line was abandoned in 1951 for economic reasons. By 1955, the long crosscut from the Argentine shaft on Silver Creek to the St. Louis tunnel on the Dolores River was finished, lowering the water level in the Silver Creek workings by 450 feet. Also in 1955, RAMC completed and put in operation a plant for the production of sulfuric acid from pyrite near the St. Louis Adit. Nine years later, the plant was put on standby basis due to a cutback in the uranium program in which the sulfuric acid was used (USGS 1974).

On May 26, 1971, all RAMC mining operations ceased, equipment below the "500 level" was removed and the lower levels allowed to flood and drain through the St. Louis Tunnel (BOM 1971). In 1973, RAMC sampled the old mine dumps and began work on a 300 foot by 500 foot leaching pad next to the old sulfuric acid plant. A Hypalon liner was installed in this leach pad. A precipitation and recovery process using three pounds of cyanide per ton of water was begun on a pile containing approximately 100,000 tons of raw ore. Early in the start-up, an overflow of the leaching liquor occurred with an unknown amount released to the Dolores River (BOM 1974). In 1974, approximately $1,200,000 of production, including gold and silver, was obtained (State of Colorado, Division of Mines (DOM) 1975a). In 1975, an additional leach pad containing 55,000 tons of raw ore was constructed in a settling pond originally used by the acid plant. A Hypalon liner was placed in this pad and a 3% to 4% cyanide solution used with added lime (DOM 1975b).

The Anaconda Copper Company (ACC) acquired the Rico Argentine Mine property from RAMC in 1980. ACC began a surface drilling program for exploration, mostly of molybdenum (Anaconda Minerals Company (AMC) 1994; DOM 1980; DOM 1981). ACC continued with both surface and underground exploratory drilling over the next several years (AMC 1994; DOM 1982; DOM 1983). ACC also built a water treatment plant at the St. Louis Tunnel discharge and carried out several other environmental efforts such as pond stabilization, adit plugging, and capping of wells (AMC 1994; WMD 1994).

In 1984, an EPA Potential Hazardous Waste Site - Site Inspection Report (Form 2070-13) was completed after a site visit by two CDH geologists. Minimal information is contained in the report although it did discuss a NPDES permit issued to RAMC in 1976 with a compliance schedule (EPA 1984a). This permit has been renewed several times and currently is in effect through September 30, 1995 (WMD 1994). The report also stated that the CDH Water Quality Control Division (WQCD) issued a Notice of Violation (NOV) and a Cease and Desist Order (CDO) in 1980 because of RAMC problems in meeting compliance limitations (EPA 1984a). The NOV and CDO were amended on December 17, 1981, and specified exceedances of zinc and copper standards. This led to the development of a water treatment system using slaked lime at the St. Louis Tunnel Adit (WMD 1994). In October 1984, E&E's Field Investigation Team (FIT) conducted a site visit which confirmed that ACC had started water treatment operations using slaked lime at the St. Louis Adit. E&E personnel also found two piezometer wells, between the Silver Creek tailings ponds and Silver Creek, apparently installed in 1981 by Dames and Moore as part of a geotechnical study on the stability and potential expansion of the ponds (E&E 1984a). A sampling plan was issued on October 18, 1984 (E&E 1984b). Field sampling was conducted on November 14, 1984 and involved the collection of nine surface water samples and eight sediment samples. No source or target samples were collected during the sampling effort. Field personnel noted that leachate appeared to be migrating from the settling ponds above Silver Creek to Silver Creek. They also noted that both surface water bodies contained iron-stained cobbles (E&E 1984b; E&E 1984c; EPA 1984b). An ARR was issued by E&E in 1985. The ARR concluded that the surface water samples contained elevated manganese concentrations and that the sediment samples contained arsenic, cadmium, copper, iron, lead, manganese and zinc at much higher concentrations than upgradient samples (E&E 1985). A NOV was issued by CDH to ACC for cadmium permit standard violations in November and December 1984 (WMD 1994).

In 1988, ACC sold their holdings in the Pioneer District, approximately 2,500 acres, to the Rico Development Corporation (RDC), a division of Crystal River Exploration and Production Company (AMC 1994; CDH 1988; EPA 1984b; WMD 1994). Fish tissue samples collected from September 1989 through March 1991, at reservoirs approximately 40 miles downstream from the R-A site, were found to contain high levels of mercury (E&E 1991a; E&E 1991b). The U.S. Department of the Interior, Bureau of Reclamation (BOR) began surface water and sediment sampling in 1989 along the upstream reaches of the Dolores River and its tributaries to determine potential sources of the mercury. This sampling has continued periodically every year through 1993. The sediment data show Silver Creek to be the major source of heavy metals, including mercury, in the upper Dolores River basin. The April 1992 water samples indicate that, in addition to Silver Creek, there are numerous sources of mercury in the upper Dolores River basin and many of them are located well downstream from Silver Creek. The study also shows metal loading from various mine drainages which contribute to contamination of the Dolores River (BOR 1994).

Since RDC obtained the property from ACC, violations of the discharge permit have continued. Another NOV and CDO were issued in 1990 for violations of lead and silver standards. Unpermitted discharge from the Blaine Tunnel on Silver Creek also was reported in 1990 which resulted in construction of a concrete dam by RDC to plug the Blaine Tunnel (WMD 1994). The St. Louis Tunnel discharge has also repeatedly failed the Whole Effluent Toxicity (WET) testing required by the NPDES permit. An additional NOV was filed in 1993 for silver violations and a notation made about wastewater flowing into the cyanide basins in which the old Hypalon liners are visibly weathered and torn. In 1994, the permit violations have included silver, lead and zinc (WMD 1994; WQCC 1993).

In April 1994, the property was sold to Azure, Inc., a development company from Phoenix, Arizona, who is looking into real estate development possibilities. Azure, Inc. has retained Walsh and Associates as a consultant (Theile 1994).

It has been reported that a large amount of tailings has been moved from tailings piles to the town of Rico for use as gravel road cover. The amount of tailings moved and the years this operation has been used are both unknown at this point (EPA 1994).

3.4 SITE GEOLOGY

Detailed information about the geology of the R-A site area can be found in "Geology of the Rico Mountains, Colorado" by Whitman Cross and Arthur Coe Spencer (USGS 1900); "Geologic Atlas of the United States, Rico Folio" by Whitman Cross and F. L. Ransome (USGS 1905) and "Geology and Ore Deposits of the Rico District, Colorado" by Edwin T. McKnight (USGS 1974).

The geology of the Rico Mountains is extremely complex with the dominant structure of the district a faulted dome centered near a monzonite stock. A central faulted horst block of Precambrian rock has been uplifted about 6,000 feet. The lower slopes of the Rico district are generally covered by debris from the hillsides from wash, talus and landslide processes (State of Colorado, Geological Survey (CGS) 1975; USGS 1900; USGS 1905; USGS 1974).

Bedrock in the district ranges from Precambrian to Permian. Precambrian rocks include older greenstone and metadiorite and later Uncompaghre Quartzite which is at least 1,000 feet thick. Overlying the Precambrian is Devonian age Ouray Limestone succeeded by Mississippian Leadville Limestone with a combined thickness of approximately 169 feet. Both formations have been metamorphosed by the monzonite intrusive body. Approximately 2,800 feet of Hermosa Formation (Middle Pennsylvanian age) is the next youngest strata. The Hermosa Formation is of great economic interest because most of the ore deposits of the district occur in it, particularly in its limestone beds. The Hermosa is overlain by the Rico Formation (300 feet thick) of Middle and Late Pennsylvanian age. The highest formation exposed in the district is the Cutler

Formation of Early Permian age with at least 2,800 feet of strata remaining (USGS 1900; USGS 1905; USGS 1974).

At the end of the Mesozoic Era, the sedimentary sequence was intruded by sills and dikes of hornblende porphyry. At a later stage, the sequence was intruded by a less silicic stock of monzonite. Channelized metamorphism may extend up to 1.7 miles from the stock (USGS 1974).

The ore deposits of the district consist of (USGS 1905; USGS 1974):

- Massive sulfide replacement deposits in the limestones of the Hermosa Formation;

- Contact metamorphic deposits of sulfides and iron oxides in limestones of Ouray, Leadville and Hermosa Formations;

- Veins on fractures and small faults in Hermosa sandstones and arkoses; and

- Replacement deposits in residual debris in lower the Hermosa Formation (the rich blanket deposits).

3.5 SITE HYDROGEOLOGY

No hydrogeologic studies of this area were located during this investigation; thus, the following discussion is based on assumptions from available geologic studies. The principal aquifer in the R-A site area is the shallow alluvial aquifer.

As stated in Section 3.4, Site Geology, the valley sides and bottom are thickly covered by detritus from weathering and erosion. This material forms a shallow unconfined aquifer through which the streams and rivers of the region flow. Hydraulic conductivity is assumed to be fairly high (10^{-2} centimeters per second (cm/s)) (Office of the Federal Register 1990). The direction of shallow groundwater flow is estimated to be south along the Dolores River and southwest along Silver Creek (EPA 1994b). Some local areas, such as near tailings piles, may seal themselves through the sifting of fine-grained material (BOR 1994). The shallow aquifer is heavily mineralized in most cases. The State of Colorado, Division of Highways, drilled a well on the south end of the town of Rico for water supply for a maintenance shop but had to abandon it after a couple of years due to heavy mineralization in the pipes (State of Colorado, Department of Transportation (CDOT) 1994; State of Colorado, Office of the State Engineer (CSE) 1994).

Deeper bedrock aquifers exist in the various limestone strata in the older formations and in the fractures in the formations. Several of the old exploratory drill holes on the Dolores River portion of the site, flowed water and had to be capped (AMC 1988; AMC 1994). Groundwater reaches the surface in the form of several seeps and springs found in the area and a number of these appear to be geothermal in nature. One drill hole is used by locals to supply hot water to a pool the locals use to soak in (Jahnke 1994). Many of the springs contain carbonic acid gas and sulphureted hydrogen (USGS 1905), some springs are calcareous due to the high carbonate of lime contained by many of the geologic formations and several springs are iron-bearing and have left local deposits of iron oxide (USGS 1900). In the vicinity of the R-A couple, deep groundwater has been allowed to flood the abandoned workings and is discharged through the St. Louis Tunnel Adit to a small treatment system (EPA 1984b; WMD 1994).

3.6 SITE HYDROLOGY

The Dolores River and its Silver Creek tributary are the major surface water bodies in the R-A site area. The Dolores River flows to the south past the St. Louis Tunnel Adit, the old sulfuric acid plant, the cyanide heap leach basins, and numerous tailings piles and settling ponds (USGS 1960). Silver Creek flows to the southwest and is the source of the town of Rico's drinking water. Below the drinking water diversion, Silver Creek flows past several mine workings including the Blaine Tunnel and the Rico-Argentine Mill and settling ponds. Silver Creek flows through the town of Rico before joining the Dolores River on the western edge of Rico. The only flow rate data is from a gage on the Dolores River at a point four miles below Rico. At this station the 41-year annual mean flow rate is 136 cubic feet per second (cfs) and the upstream drainage basin encompasses 105 square miles (mi^2) (USGS 1993). The Dolores River is not used as a source of municipal drinking water; however, there are twelve listed diversions within fifteen downstream miles of the R-A site. The St. Louis Tunnel is the only diversion with domestic use listed, as well as industrial and stockwatering; however, it is doubtful that any domestic use actually occurs from this water source. The other surface water diversions are used for irrigation, stockwatering, industrial, recreation, fire and other purposes (CSE 1994).

3.7 SITE METEOROLOGY

The R-A site is located in a semiarid climate zone. The mean annual precipitation, as totaled from the University of Delaware (UD) database, is 12.8 inches. The net annual precipitation as calculated from precipitation and evapotranspiration data obtained from the UD is 4.1 inches (University of Delaware (UD) 1986). The 2-year, 24-hour rainfall event for the site is approximately 1.5 inches (Dunne and Leopold 1978).

4.0 PRELIMINARY PATHWAY ANALYSIS

This following analysis will consider potential site impacts on the air pathway, groundwater pathway, surface water pathway, and soil exposure pathway utilizing HRS guidelines (Office of the Federal Register 1990).

4.1 SITE SOURCE QUANTITY AND CHARACTERISTICS

Source areas at the R-A site include the estimated 75 acres of tailings piles and settling ponds along both the Dolores River and Silver Creek and an unknown amount of tailings moved into the town of Rico as street cover. This material has been removed from mining operations near Rico and has reportedly caused dying yards in Rico (EPA 1984b; EPA 1993). The St. Louis Tunnel discharge of 1.1 to 1.5 MGD is also considered a R-A source (WMD 1994).

The source areas are estimated to contain 400,000 tons of material at the R-A site (EPA 1984b). A number of sampling efforts have been conducted at the site. These include an ACC contractor from 1980 through 1983, EPA-sponsored sampling in 1984 and BOR sampling from 1989 through 1993. These sampling efforts focused on surface water and sediment analyses (EPA 1984b; E&E 1985; BOR 1994). No characterization of the tailings piles, tailings ponds or settling ponds has been located in the file search; however, review of geologic studies, mining texts and personal conversations with employees of the old mining companies, leads to an assumption that cyanide and the heavy metals typically associated with sulfide ores would be the contaminants of concern in the source areas. No mention of the use or storage of any other hazardous wastes was found in the files.

From reports in EPA, CDH and BOR files, it is assumed that all tailings piles, tailings ponds and settling ponds were constructed with native material without liners or run-on/runoff controls. The two cyanide heap leach pads that were built did incorporate Hypalon liners and overflow berms but these have not been maintained to the present time (BOM 1974; DOM 1975b, WMD 1994).

4.1.1 Source Area Data Gaps

No source characterization sampling has been conducted at the R-A site.

4.2 AIR PATHWAY

No ambient air monitoring has been performed at the R-A site. The air pathway was evaluated on the potential to release.

4.2.1 Target Populations

Approximately 92 people live in the town of Rico and 123 residents are listed in the U.S. Census Bureau's Rico division which is within the four-mile target distance limit (U.S. Department of Commerce (USDOC), Bureau of the Census 1990). The Rico area is experiencing recent population growth due to growth and overcrowding in Telluride. Due to the tailings that have been moved into Rico, it is assumed that all 92 residents of Rico live on a source area. From U.S.

Geological Survey topographic maps, the portion of Rico that appears to still have houses covers approximately two square miles equal to 1,280 acres (USGS 1960). It has been reported that ACC owned 2,500 acres in the Rico area; from this it is assumed that all 123 residents of the Rico division live on a source area.

The federally listed threatened and endangered Bald eagle (*Haliaeetus leucocephalus*) (threatened), Peregrine falcon (*Falco peregrinus*), Mexican spotted owl (*Strix occidentalis lucida*) (threatened), Southwestern Willow Flycatcher (*Empidonox trailli extimus*) (proposed endangered), and Black-footed Ferret (*Mustela Nigripes*) (endangered) potentially inhabit the area (U.S. Department of the Interior, Fish and Wildlife Service (FWS) 1994). Federal candidate (Category 2) species North American wolverine (*Gulo gulo luscus*), Northern goshawk (*Accipiter gentilis*), Black Tern (*Chlidonias niger*), Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*), Round tail chub (*Gila robusta*), and Flannelmouth sucker (*Catostomus latipinnis*) may also inhabit the Rico area (FWS 1994).

No National Wetland Inventory maps have yet been prepared for this area (Earth Science Information Center (ESIC) 1994). The EPA's 1984 sampling effort did not identify wetlands or critical habitat within one mile of the site (EPA 1984b); however, it is reasonable to assume that forested and emergent wetland vegetation exists within the specified four-mile target distance limit. A significant community of montane riparian forest (*Populous augustifolia-Picea pungens/Alnus incana*) can be found on the east bank of the Dolores River within four miles of the site. This natural community is ranked rare to uncommon both globally and in Colorado (Colorado Natural Heritage Program (CNHP) 1994).

4.2.2 Air Pathway Specific Data Gaps

After performing an analysis of all potential sources on site, URS was not able to identify additional areas where data acquisition is required.

4.3 GROUNDWATER PATHWAY

The groundwater pathway was evaluated on the potential to release. No groundwater monitoring data is available. The CPDES permit monitoring does show a release of silver, lead and zinc from groundwater drainage discharging from the St. Louis Tunnel (WMD 1994).

4.3.1 Target Populations

The population potentially impacted by groundwater contamination consists of the users of three wells listed as household use by the Colorado State Engineer (CSE 1994). Two of these wells are located approximately one-half mile upgradient of the St. Louis Tunnel Adit and it's associated sources on the Dolores River. According to the owner of one of these wells, no water quality problems have been encountered since drilling the well for a drinking water source in 1990 (Jahnke 1990). The state engineer lists the well depth as 160 feet; however, the owner was unsure what depth the screened interval was placed (CSE 1994; Jahnke 1994). The third domestic well is at the south end of the town of Rico, approximately one and one-half miles downgradient of the source areas and below the confluence of Silver Creek and the Dolores River (CSE 1994; USGS 1960). Approximately six people use these wells, possibly for drinking water (Jahnke 1994; USDOC 1990).

4.3.2 Wellhead Protection Area

The R-A site does not lie within a state or federally designated wellhead protection area (State of Colorado, Department of Health, Water Quality Control Division (WQCD) 1994).

4.3.2.1 Resource Use

Groundwater within the specified four-mile target distance limit is limited to the three household wells discussed in Section 4.3.1 and one industrial use well owned by the Rico Development Corporation (CSE 1994).

4.3.3 Groundwater Pathway Specific Data Gaps

After performing an analysis of all potential site-related sources and associated receptor targets, URS has been able to identify the following area where additional data acquisition is required:

- Water quality analyses of the three domestic wells, particularly the single downgradient well.

4.4 SURFACE WATER PATHWAY

The surface water pathway was evaluated on observed release. Section 3.3, "Site History and Preview Work," describes a number of investigations and sampling efforts in the Rico area. EPA consultants observed leachate from settling ponds on Silver Creek entering the surface water, and iron-stained cobbles in both Silver Creek and the Dolores River. The same consultant sampled surface water and sediments and detected elevated manganese in the surface water and elevated arsenic, cadmium, copper, iron, lead, manganese and zinc in the sediments. Sampling by the BOR determined that Silver Creek is the major source of mercury and other heavy metals in the upper Dolores River basin. In addition, there have been numerous and continuing permit violations for the R-A settling pond discharge point to the Dolores River. These violations have been of cadmium, lead, silver and zinc. Observations have been made of wastewater flowing into cyanide basins with potentially leaking liners (WQCD 1993).

4.4.1 Drinking Water Threat

The drinking water threat is used to evaluate the threat associated with the actual or potential release of hazardous substances from a site to drinking water resources. There are no municipal drinking water diversions within fifteen downstream miles from the R-A site on the State Engineer's Water Rights

Report. There are twelve total diversions on the Dolores River, one of which includes domestic use in its multiple use codes. This water right is listed as the St. Louis Tunnel and includes industrial and stockwatering as its other uses (CSE 1994).

The town of Rico obtains its drinking water from a diversion on Silver Creek above the potential impacts from R-A mining operations (Figure 2). The water is treated through infiltration galleries and chlorinated (E&E 1984c).

4.4.2 Human Food Chain Threat

The human food chain threat is used to evaluate the threat associated with the actual or potential release of hazardous substances to surface water containing human food chain organisms. ACC contractors found decreased aquatic life in the Dolores River in the 1980s, but did not attribute it to the site (EPA 1984b). A number of federally listed threatened and endangered fish may utilize the surface water habitat as discussed in the next section under Environmental Threat.

The State of Colorado, Division of Wildlife (CDOW) conducted fish studies on two 500 foot reaches of the Dolores River near Spruce Creek, one and one-half miles below Rico, in 1982 and found three rainbow trout between ten and twelve inches in length and one small brown trout. The CDOW performed habitat improvement in the form of instream boulders and check dams which led to increased populations of brown trout between five and six inches in length in 1983. By 1984, CDOW fish sampling showed greatly increased populations of ten to twelve inch brown trout and slightly increased populations of rainbow and brook trout (State of Colorado, Division of Wildlife (CDOW) 1994a). Local bait and tackle shops confirmed the presence of harvestable game fish in the upper reaches of the Dolores River (Duranglers 1994). The Dolores River above Rico experiences heavy fishing pressure and CDOW stocks fish in the river through the town of Rico. The upper head-waters of the Dolores River support a viable native cutthroat trout fishery. Silver Creek has little aquatic life because of the heavily mineralized water below the mines; however, CDOW has stocked native cutthroat trout approximately two miles above Rico in Silver Creek and they are doing relatively well (CDOW 1994b).

4.4.3 Environmental Threat

The environmental threat is used to evaluate the threat associated with the actual or potential release of hazardous substances from a site to sensitive environments specified by state and federal statutes. While no National Wetland Inventory maps are available for the upper Dolores River area, it may be assumed that a limited amount of emergent vegetation exists within the specified fifteen-mile downstream target distance limit. The 1984 EPA sampling effort did not identify wetlands or critical habitats within one mile of the site (EPA 1984b). A significant montane riparian forest can be found on the east bank of the Dolores River within four downstream miles of the site area (refer to Section 4.2.1 for more discussion). Another montane riparian forest community (*Populous augustifolia/Cornus sericea*) occurs along the Dolores River approximately fifteen miles downstream from the R-A site. This natural community is ranked very rare globally and in Colorado (CNHP 1994).

Federally listed threatened and endangered aquatic species that potentially use the Dolores River include the Colorado squawfish (*Ptychocheilus*), the Humpback chub (*Gila cypha*), the Bonytail chub (*Gila elegans*) and the Razorback sucker (*Xyrauchen texanus*). Federal candidate species include the Flannelmouth sucker (*Catostomus latipinnis*), the Roundtail chub (*Gila robusta*) and the Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*) (FWS 1994a; FWS 1994b).

4.4.4 Surface Water Pathway Specific Data Gaps

After performing an analysis of all potential site-related sources and associated receptor targets, URS identified the following data gap with regard to the surface water pathway:

- Determination of whether proximal impacted wetlands are present on the Dolores River.

4.5 SOIL EXPOSURE PATHWAY

The soil exposure pathway was evaluated based on the containment of on-site sources and the presence of observed contamination to both on- and off-site soils. No soil sampling has been conducted at the R-A site.

4.5.1 Target Populations

4.5.1.1 Resident Populations

There are no known residents living on the R-A site or within 200 feet of source areas at the R-A site (USGS 1960). The site is inactive; therefore, no workers are on-site.

4.5.1.2 Nearby Populations

Based on census data for the town of Rico, the Rico division and Dolores County, approximately 123 people reside on, or live within 200 feet of, contaminated soil areas (USDOC 1990; USGS 1960). There are no restrictions to access of source materials on the site. Access roads lead to mine adits, mills, tailings and ponds with no gates or fencing (EPA 1984b). Most of the mining properties in the R-A region were originally patented and are now on private property with approximately 2,500 acres combined under one ownership. The R-A area is situated within the San Juan National Forest with small public land parcels mixed within the private mining properties. The area receives high recreational use.

4.5.1.3 Terrestrial Sensitive Environments

The endangered Black-footed ferret and Bald eagle may utilize the R-A area. The proposed endangered Southwestern willow flycatcher and threatened Mexican spotted owl also may be found in the Rico area (FWS 1994a; FWS 1994b). The federal candidate species North American wolverine, Black Tern and Northern goshawk may utilize the site area as habitat (FWS 1994a; FWS 1994b). Several montane riparian sensitive communities are also found in the area (CNHP 1994).

4.5.2 Soil Exposure Pathway Specific Data Gaps

After evaluating all potential site sources and associated nearby population targets, URS has identified the following data gaps with regard to the soil exposure pathway:

- No residential soil sampling has been conducted at the R-A site.

5.0 SUMMARY

The R-A site is an inactive mining area which began operations over 100 years ago as a silver producer. In later periods of operation, base-metal production from sulfide ores and sulfuric acid from pyrite ores were the major goals of the mining operations. The site exists in three areas: The Rico-Argentine Mill, mines and associated tailings piles and ponds on Silver Creek; a sulfuric acid plant, cyanide heap leach pads and settling ponds on the Dolores River; and tailings that have been moved into Rico for road cover. Cyanide heap leaching has been used in two lined ponds with at least one minor release of leachate. All mine water drainage has been routed through underground workings to discharge from the St. Louis Tunnel Adit on the Dolores River. The discharge is treated with slaked lime and is under a Colorado Pollutant Discharge Elimination System permit with input from the EPA's NPDES division. The permit limits have been continuously violated with at least two Notice of Violation and Cease and Desist Orders issued by CDH.

Approximately 123 people reside in the Rico area. Most of these residents are probably located on contaminated soils or within 200 feet of contaminated soils. There are no restrictions to access to the site. Approximately six residents potentially use groundwater as a drinking water source. Several federally listed threatened and endangered species potentially use the area or exist within the specified target distance limits. Fish are taken from the Dolores River within the fifteen-mile downstream target distance limit, but the quantity of fish taken from the river is unknown.

During this evaluation, URS was able to identify the following significant data gaps which exist for the R-A site:

- Source characterization has not been conducted;
- Location and sampling of proximal wetlands along the Dolores River (surface water pathway);
- Residential soil sampling has not been conducted at the R-A site; and
- Confirmation of the presence of threatened and endangered species.

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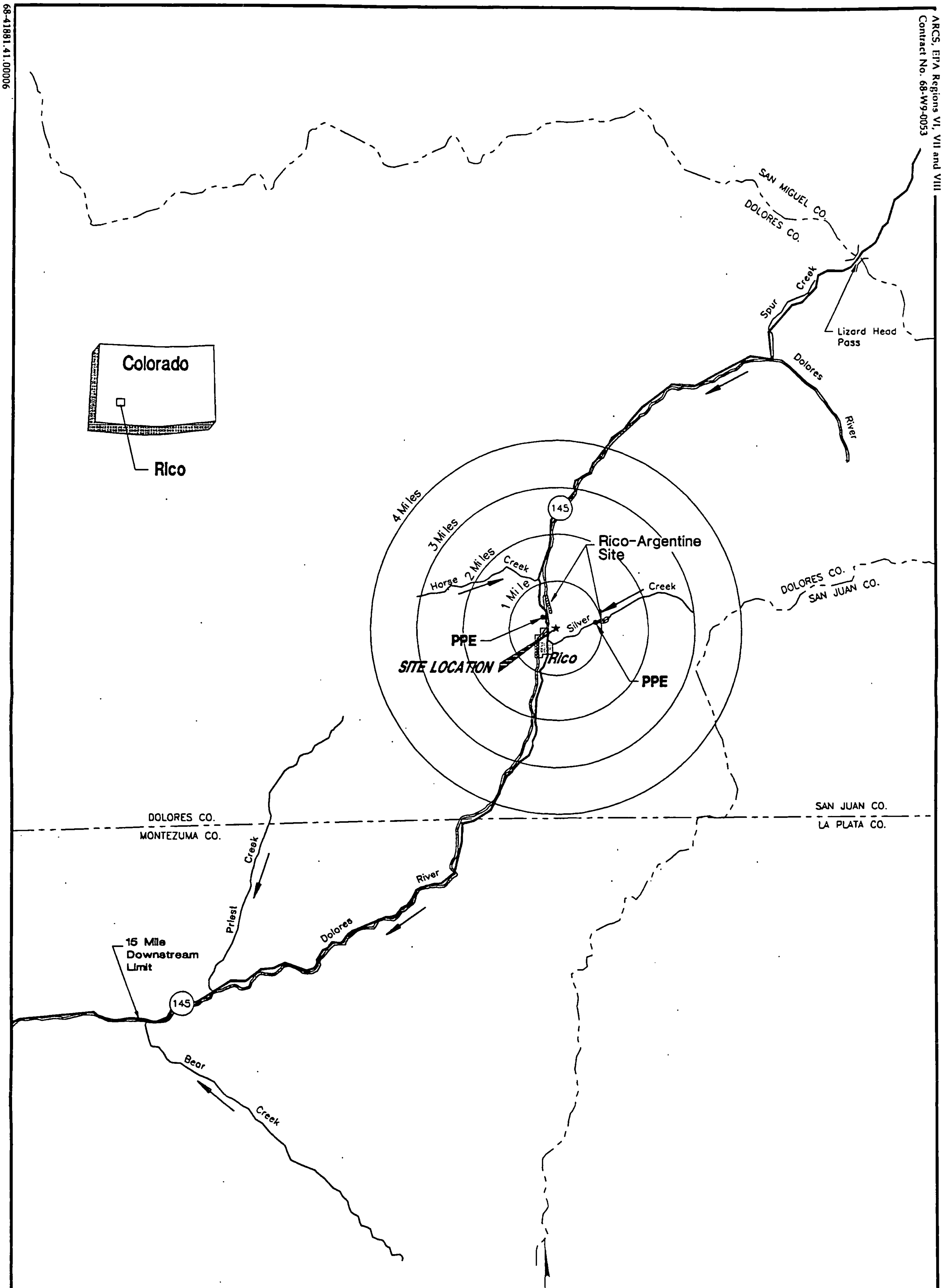


SOURCE:
USGS 30x60 Minute Topographic Quadrangle:
1:100,000 scale, Dove Creek; 1982, Silverton; 1982

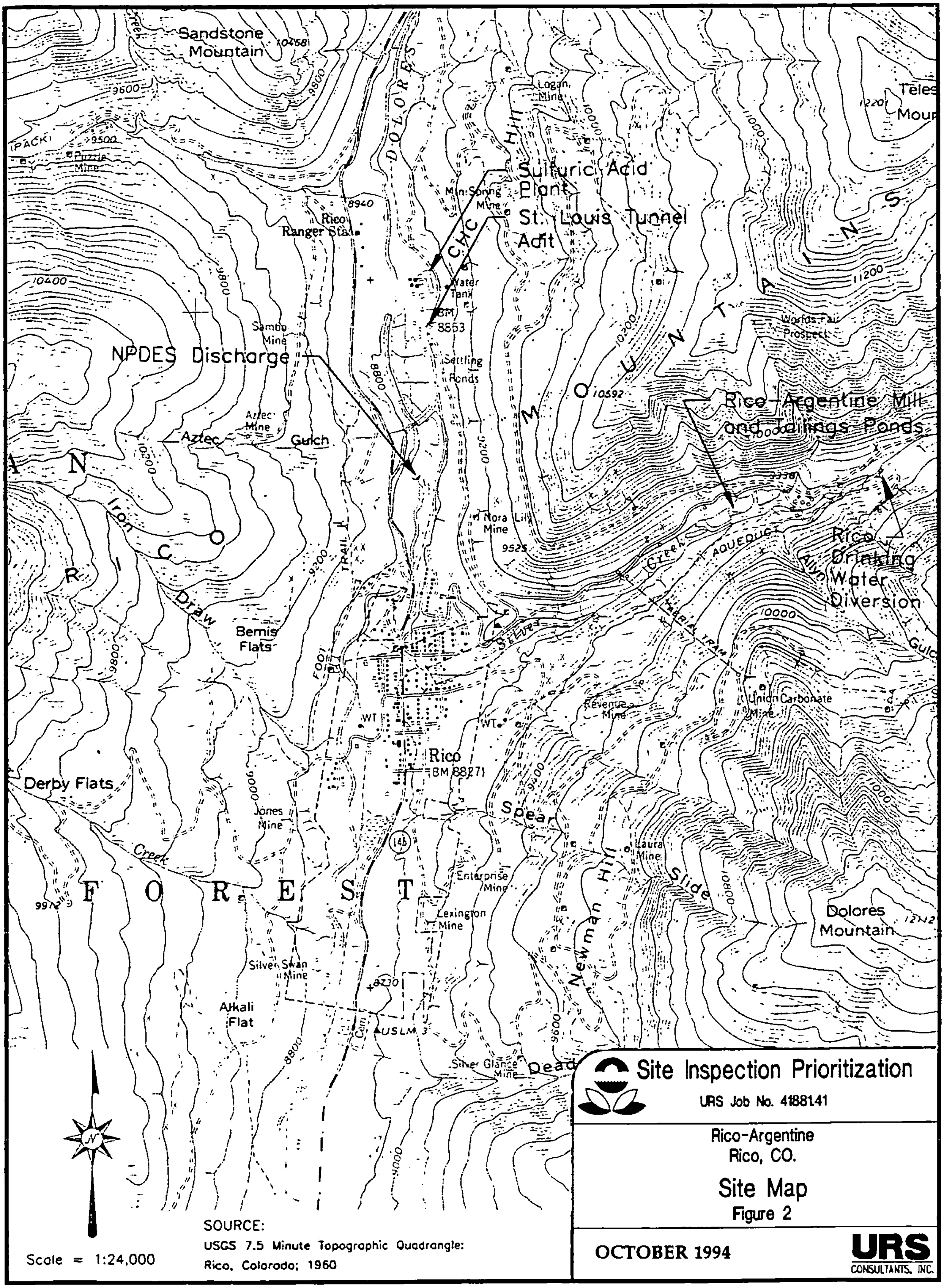
Site Inspection Priortization
URS Job No. 4188141

Rico-Argentine
Rico, CO.

Area of Influence Map
Figure 1

OCTOBER 1994

URS CONSULTANTS, INC.


Sulfuric Acid Plant
St. Louis Tunnel Adit
NPDES Discharge
Rico-Argentine Mill and Tailings Ponds
Rico Drinking Water Diversion
Sandstone Mountain
Dolores Mountain
Rico
Site Inspection Prioritization
URS Job No. 418814.1
Rico-Argentine
Rico, CO.
Site Map
Figure 2
OCTOBER 1994
URS CONSULTANTS, INC.
SOURCE:
USGS 7.5 Minute Topographic Quadrangle:
Rico, Colorado; 1960
Scale = 1:24,000

APPENDIX A
EPA PA Worksheet

PA WORKSHEET

Site Name Rico-Argentine City, State Rico, Colorado

CERCLIS ID # COD980952519

Reported by Michael V. Carr Date October 11, 1994

HIGHLIGHTS:

A) IS THERE QUALITATIVE OR QUANTITATIVE EVIDENCE OF A RELEASE TO AIR, SURFACE WATER, GROUNDWATER, OR SURFACE SOIL? DESCRIBE BRIEFLY.
More detail in items GW-1 (for groundwater pathway), SW-5 (for surface water pathway), A-1 (for air pathway), and SE-1 (for soil exposure pathway).

Yes, to surface water. Surface water samples collected for NPDES monitoring repeatedly detect violations of permit standards for several metals. Surface water and sediment samples collected from 1989 through 1993 by the Bureau of Reclamation show metals loading to the drainages.

B) IS THERE EVIDENCE OF AN IMPACTED TARGET POPULATION? DESCRIBE.

Pathway	Target	None/ Target Size	Brief Description	More Discussion In
Groundwater	Public drinking Water supply Domestic drinking Water supply	None *ND (6)	Three wells within a four-mile radius are listed as household use. No impacts noticed by users.	Section 4.3, 5.0
Surface Water	Drinking water Fishery Sens. env.	123 *ND *ND	The upper Dolores River and upper Silver Creek are viable fisheries. CDOW improved aquatic habitat in the Dolores River below Rico in 1982 which has increased trout populations to harvestable sizes. There have been several NPDES violations on Dolores River.	Section 4.4, 5.0
Soil Exposure	People within 200' Terrestrial sens. env.	123 *ND	Federal candidate species and state species of concern potentially exist in site area as well as several threatened and endangered species.	Section 4.5, 5.0
Air	Population	123	No air monitoring has been conducted.	Section 4.2

*ND - Not Determined

SITE INFORMATION

G-1. Directions to the site (from nearest easily recognized point).

From Telluride, Colorado, proceed south on State Highway 145, over Lizard Head Pass, approximately 30 miles.

G-2. Are there other potential sources in the neighborhood to be aware of as the site is evaluated? eg. Is the site in an industrial area, near a railroad, along a highway? Are sources with similar contaminants to this site in the vicinity?

Yes. Site area is heavily mined, site sources are major sources in the area; however, there are several other historical mining sites in the area, unrelated to R-A, which may affect the environment. One example is the Mountain Springs/Spill Mine upstream near the headwaters of Silver Creek which is reported to have a low pH.

Source of information: CDH Files; EPA Files; EPA 1993; USGS 1900; USGS 1905; USGS 1974

Background/Operating History

G-3. Describe the operating history of the site:

Early mining began in 1861. Silver production peaked in the 1890s and base-metal ore production peaked in 1927. A sulfuric acid production plant operated from 1955 through 1964. All mining operations ceased in 1971. Cyanide heap leaching occurred from 1973 through the late 1970s. Anaconda Minerals Company owned the property from 1980 to 1988 and explored for molybdenum. Rico Development Corporation owned the property from 1988 to April 1994 when they sold their interests to Azure, Inc., from Phoenix, Arizona. A NPDES permit was obtained in 1976. Frequent violations of the permit have occurred. BOR sampling shows loading of heavy metals to the adjoining surface water drainages.

Source of information: AMC 1994; BOM 1915; BOM 1939a; BOM 1939b; BOM 1940; BOM 1942b; BOM 1943; BOM 1949a; BOM 1974; CDH 1988; DOM 1975a; DOM 1975b; DOM 1980; DOM 1981; DOM 1982; DOM 1983; E&E 1984a; E&E 1984b; E&E 1985; E&E 1991a; E&E 1991b.

G-4. Describe site and nature of operations (property size, manufacturing, waste disposal, storage etc.):

See #G-3. Approximate site acreage is 2,500 acres. Mills, tailings piles and settling ponds near the surface water bodies cover approximately 75 acres. Many other tailings piles are located in the site area. Some tailings have been moved into the town of Rico as gravel road cover with a reported effect of dying yards. The town of Rico covers approximately 1,280 acres. Tailings piles, tailings ponds and settling ponds typical of hardrock mining comprise the source areas.

Source of information: EPA 1984a; EPA 1984b; EPA 1993; USGS 1905; USGS 1974; EMD 1994.

G-5. Describe any emergency or remedial actions that have occurred at the site:

None. Anaconda did some environmental work (plugged adits, maintained settling ponds, built water treatment plant) while they owned the property.

Source of information: AMC 1994, CDH files, EPA files.

G-6. Are there records or knowledge of accidents or spills involving site wastes? Are there Emergency Response Notification (ERNs) reports for this location?

None.

Source of information: EPA files.

G-7. Describe existing sampling data and briefly summarize data quality (e.g. sample objective, age/comparability, analytical methods, detection limits, QA/QC, validatability):

Sampling of surface water is conducted periodically for the NPDES permit. Methods and QA/QC are unknown. BOR sampling has been conducted yearly to trace mercury and other metals loading in the Dolores River and its tributaries.

Source of information: BOR 1994, WMD 1994.

G-8. Is there any other local, state or federal regulatory involvement? Describe. Include permits, and names of contact individuals within each government organization.

AGENCY	PROGRAM	CONTACT	PHONE	PERMIT
CDH	NPDES	Kathleen Kalamen	692-3603	CO-0029793

G-9. Attach site sketch or schematic. Include all pertinent features including wells, storage areas, underground storage tanks, source areas, buildings, access roads, areas of ponded water. Refer to figure(s) submitted with text of report if appropriate.

Refer to figures 1 and 2.

SOURCE CHARACTERIZATION

WC-1. Describe each source at the site, on Table 1, in terms of source type, containment, size/area/volume/quantity, and substances present. See HRS Tables 2-5 and 5-2 for source descriptions, Tables 3-2, 4-2, 4-8, 5-6, 6-3, and 6-9 for containment.

WC-2. Briefly describe how waste quantity was estimated (eg. historical records or manifests, permit applications, air photo measurements, etc.):

EPA's sampling team in 1984 estimated the total size and amount of source material on the site.

Source of information: EPA 1984a; EPA 1984b.

WC-3. Describe any restrictions or barriers to accessibility of on-site sources.

None.

Source of information: 1984b.

GROUNDWATER CHARACTERISTICS

GW-1. Any positive or circumstantial evidence of a release to groundwater? Describe.

Yes. Surface water and sediment sampling show metals loading to these media. Valley fill and alluvial material form an unconfined aquifer that potentially interacts with mine water discharge and surface water bodies. No specific groundwater sampling has been conducted other than mine discharge for NPDES monitoring.

Source of information: EPA 1984b; USGS 1900; USGS 1905; USGS 1974; WMD 1994.

GW-2. Any positive or circumstantial evidence of a release to drinking water users? Describe analytes, detection limits, background, hits, number of users, locations, QA/QC.

None reported. Three household use wells are within the four-mile target distance limit and serve approximately six residents. Two of these wells are approximately three-quarters of a mile upgradient. The other is located within the town of Rico, potentially near tailings used as road cover. All other drinking water sources are surface water diversions from above the site area.

Source of information: CDH files; EPA files; WMD 1994.

GW-3. Briefly describe the geologic setting.

Alluvial material from wash and landslides masks the underlying geology. A shallow unconfined aquifer exists in the alluvial material. The Cutler Formation is the youngest formation exposed at the site and is at least 2,800 feet thick. Fractures in bedrock forms a deeper aquifer. Geothermal Springs are found in the site area.

GW-4. Describe geologic/hydrogeologic units on Table 2. Give names, descriptions, and characteristics of consolidated and unconsolidated zones beneath the site.

GW-5. Is the site in an area of karst terrain or a karst aquifer?

No.

GW-6. Net Precipitation (per HRS section 3.1.2.2).

4.1 inches.

SURFACE WATER CHARACTERISTICS

SW-1. Mean annual precipitation (per HRS section 4.0.2)= 12.8". If less than 20", then count intermittent channels as surface water.

SW-2. Discuss the probable surface water flow pattern from the site to surface waters:

The tailings piles from the Rico-Argentine Mill are in Silver Creek with tailing ponds apparently draining directly into Silver Creek. The St. Louis Tunnel Adit drains into a slaked lime treatment system and then a series of settling ponds before discharging into the Dolores River. This discharge has a NPDES permit.

Source of information: EPA 1984b; WMD 1994.

SW-3. If surface water exists within 2 miles of the site, describe surface water segments within the 15-mile distance limit.

Segment Name	River/Lake/Type	Fresh/Salt Water	Start (mi.)	End (mi.)	Flow In cfs
Dolores River	River	Fresh	0	15	136
Silver Creek	Creek	Fresh	0	0.75	ND

Groundwater to surface water distance N/A Angle Θ ____

SW-4. Provide a schematic diagram or simple figure which describes surface water segments, locates targets, identifies flow direction, PPE(s), etc. Refer to figure(s) submitted with text of report if appropriate.

Refer to figures 1 and 2.

SW-5. Any positive or circumstantial evidence of a release to surface water? Evidence of a release by direct observation? Is the source located in surface water? Describe.

Yes. Tailing piles are placed in Silver Creek and tailings ponds are discharging to Silver Creek. Surface water and sediment samplings performed by BOR in Silver Creek and the Dolores River show metals loading occurring. The NPDES monitoring sampling show repeated exceedances of permit standards for metals.

Source of information: BOR 1994, WMD 1994.

SW-6. Any positive or circumstantial evidence of a release to surface water target populations? Describe analytes, detection limits, background, hits, number of users, locations, QA/QC.

No. An ACC contractor in the 1980s found decreased aquatic life in the Dolores River below the site but could not attribute the situation to the site. No target-specific sampling has been conducted at this site.

Source of information: EPA 1984b.

SW-8. Is the site or portions thereof located in surface water? Yes.

Is the site located in the 1 - <10 yr floodplain?

>10-100 yr?

>100-500 yr?

>500 yr?

SW-9. Two-year 24-hour rainfall 1.5"

TARGETS

T-1. Discuss groundwater usage within four miles of the site:

There are no municipal wells within the specified four-mile target distance limit. Five wells are listed by the CSE; one owned by the CDOT for wash water in a maintenance shop, one is listed as industrial use and three are listed as household use. Two of the household wells are approximately three-quarters of a mile upgradient and one is approximately three-quarters of a mile downgradient.

Source of information: CSE 1994, USDOC 1990.

T-2. Summarize the drinking water population served via groundwater within four miles of the site:

0 - 1/4 mi	1
1/4 - 1/2 mi	5
1/2 - 1 mi	0
1 - 2 mi	0
2 - 3 mi	0
3 - 4 mi	0

Attach calculations for population apportionment in blended systems.

T-3. Identify and locate any of the following surface water targets within 15 miles of the site: drinking water population(s) served by intakes, fisheries, sensitive environments described in Table 4-23 of the HRS, and wetlands as defined in the Federal Register.

Targets	Dist. From Site	SW Body	Flow In cfs	Population Served/Size (Incl. Units)	Contamination Known/Suspected
Montane riparian	4 miles	Dolores River	136	ND	Metals
Dolores Fishery	1 mile	Dolores River	136	ND	Metals

One surface water diversion is listed as multiple use including domestic. This diversion is the St. Louis Tunnel, actual domestic use is unknown.

T-4. Summarize the population within a four-mile radius of the site:

	Total Pop.	Worker Pop.
on site	0	0
0 - 1/4 mi	0	
1/4 - 1/2 mi	8	
1/2 - 1 mi	76	
1 - 2 mi	18	
2 - 3 mi	10	
3 - 4 mi	11	

T-5. Identify and locate any terrestrial sensitive environments described in Table 5-5 of the HRS.

Potential habitat for federal candidates species, North American Wolverine and Northern Gas Hawk. Potential habitat for federally listed threatened and endangered Bald Eagle, Peregrine Falcon and Mexican Spotted Owl. Potential habitat for montane riparian forest that is ranked very rare globally and in Colorado.

T-6. Describe any positive or circumstantial evidence of a release to air target populations? Of a release by direct observation where target population exists within 1/4 mile of the site? Describe analytes, detection limits, background, hits, number of users, locations, QA/QC.

No air monitoring has been conducted at this site. No observations are available concerning dust from tailings or ponds blowing off-site.

T-7. Identify and locate any potential or known resident soil exposure populations, if present. Describe conditions which lead the researcher to suspect contaminated soil within 200' of residences, if this condition exists.

None known.

TABLE 1
WASTE CONTAINMENT AND HAZARDOUS SUBSTANCE IDENTIFICATION[1]

SOURCE TYPE	SIZE (Volume/Area)	ESTIMATED WASTE QUANTITY	SPECIFIC COMPOUNDS	CONTAINMENT[2]	SOURCES OF INFORMATION
Tailing piles, ponds	75 acres	400,000 tons	Heavy metals, cyanide	None	CDH files; EPA files
Mine adits		1.5 million gallons per day	Heavy metals	Lime treatment system	WMD files

1 Use additional sheets if necessary.

2 Evaluate containment of each source from the perspective of each migration pathway (e.g., groundwater pathway - non-existent, natural or synthetic liner, corroding underground storage tank; surface water - inadequate freeboard, corroding bulk tanks; air - unstabilized slag piles, leaking drums, etc.)

TABLE 2
HYDROGEOLOGIC INFORMATION[1]

STRATA NAME/DESCRIPTION	THICKNESS (ft.)	HYDRAULIC CONDUCTIVITY (cm/sec)	TYPE OF DISCONTINUITY[2]	SOURCE OF INFORMATION
Alluvial Fill	10-40	10^{-2}	None	EPA 1984b; Office of the Federal Register 1990; USGS 1900; USGS 1905; USGS 1974
Bedrock (Cutler and older Formations)	> 2,800	10^{-5}	None	EPA 1984b; Office of the Federal Register 1990; USGS 1900; USGS 1905; USGS 1974

1 Use additional sheets if necessary.

2 Identify the type of aquifer discontinuity within four-miles from the site (e.g., river, strata "pinches out", etc.).

ARCS

Remedial Planning Activities
At Selected Uncontrolled
Hazardous Substance Disposal Sites
In The Zone of Regions VI, VII and VIII

Environmental Protection Agency

Contract No. 68-W9-0053

SITE INSPECTION PRIORITIZATION

Rico-Argentine
Rico, Colorado

Work Assignment No. 21-8JZZ

OCTOBER ~~4~~ 11, 1994

URS
CONSULTANTS, INC.

Brown and Caldwell
Harza Environmental Services, Inc.
Shannon & Wilson, Inc.
Western Research Institute

October ~~6~~ 11, 1994

Mr. Robert Heise
Work Assignment Manager
Superfund Remedial Action Branch
Hazardous Waste Management Division
United States Environmental Protection Agency
Region VIII, Mail Code: 8HWM-WAM
999 - 18th Street, Suite 500
Denver, Colorado 80202-2405

SUBJECT: ARCS VI, VII AND VIII, CONTRACT NO. 68-W9-0053, WA #21-8JZZ
Site Inspection Prioritization (SIP), Rico-Argentine, Rico, Colorado

Dear Mr. Heise:

Attached please find a copy of the final Site Inspection Prioritization (SIP) for Rico-Argentine, in Rico, Colorado for your review and approval. ~~The Rico-Argentine scenario in PREscore obtained a score of 50.12 with an assumption of one pound of harvestable fish collected from the Dolores River. The fact that edible fish are being taken from the river is not totally certain based on conversations with CDOW staff and fishing shops in Durango; however, even without the fish the site scores a 30.20 based on the rare plant community on the banks of the Dolores River, four miles downstream from the R-A site. What-if scenario's assuming additional wetlands did not change the score, but wetlands has been added as a data gap in the event that the rare plant community has ceased to exist. Additional scenarios included on the attached disc include R-Asoil (35.12) which did not include fish poundage but assumed 123 residents at Level II soil contamination exposure. With the fish poundage added to the soil exposure (R-Asoils) the score increased to 53.23.~~

While analytical data from previous sampling investigations and from permit enforcement activities has been considered in this SIP, no effort to determine the data quality for rulemaking has been made at this time. The level of effort required for analyses of data from previous investigations is beyond the scope of a generic SIP.

If you have any questions concerning this report, please call me at 296-9700.

Very truly yours,

URS CONSULTANTS, INC.

T. F. Staible
Program Manager

Attachment

cc: Pat Smith/EPA/Region VIII — with attachment
Michael V. Carr/URS/Denver — with attachment
ARCS File/URS/Denver — with attachment

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industrial use well owned by the Rico Development Corporation (CSE 1994).

4.3.3 Groundwater Pathway Specific Data Gaps

After performing an analysis of all potential site-related sources and associated receptor targets, URS has been able to identify the following area where additional data acquisition is required:

- Water quality analyses of the three domestic wells, particularly the single downgradient well.

4.4 SURFACE WATER PATHWAY

The surface water pathway was evaluated on observed release. Section 3.3, "Site History and Preview Work," describes a number of investigations and sampling efforts in the Rico area. EPA consultants observed leachate from settling ponds on Silver Creek entering the surface water, and iron-stained cobbles in both Silver Creek and the Dolores River. The same consultant sampled surface water and sediments and detected elevated manganese in the surface water and elevated arsenic, cadmium, copper, iron, lead, manganese and zinc in the sediments. Sampling by the BOR determined that Silver Creek is the major source of mercury and other heavy metals in the upper Dolores River basin. In addition, there have been numerous and continuing permit violations for the R-A settling pond discharge point to the Dolores River. These violations have been of cadmium, lead, silver and zinc. Observations have been made of wastewater flowing into cyanide basins with potentially leaking liners (WQCD 1993).

4.4.1 Drinking Water Threat

The drinking water threat is used to evaluate the threat associated with the actual or potential release of hazardous substances from a site to drinking water resources. There are no municipal drinking water diversions within fifteen downstream miles from the R-A site on the State Engineer's Water Rights Report. There are twelve total diversions on the Dolores River, one of which includes domestic use in its multiple use codes. This water right is listed as the St. Louis Tunnel and includes industrial and stockwatering as its other uses (CSE 1994).

The town of Rico obtains its drinking water from a diversion on Silver Creek above the potential impacts from R-A mining operations (Figure 2). The water is treated through infiltration galleries and chlorinated (E&E 1984c).

4.4.2 Human Food Chain Threat

The human food chain threat is used to evaluate the threat associated with the actual or potential release of hazardous substances to surface water containing human food chain organisms. ACC contractors found decreased aquatic life in the Dolores River in the 1980s, but did not attribute it to the site (EPA 1984b). A number of federally listed threatened and endangered fish may utilize the surface water habitat as discussed in the next section under Environmental Threat.

The State of Colorado, Division of Wildlife (CDOW) conducted fish studies on two 500 foot reaches of the Dolores River near Spruce Creek, one and one-half miles below Rico, in 1982 and found three rainbow trout between ten and twelve inches in length and one small brown trout. The CDOW performed habitat improvement in the form of instream boulders and check dams which led to increased populations of brown trout between five and six inches in length in 1983. By 1984, CDOW fish sampling showed greatly increased populations of ten to twelve inch brown trout and slightly increased populations of rainbow and brook trout (State of Colorado, Division of Wildlife (CDOW) 1994a). Local bait and tackle shops confirmed the presence of harvestable game fish in the upper reaches of the Dolores River (Duranglers 1994). The Dolores River above Rico experiences heavy fishing pressure and CDOW stocks fish in the river through the town of Rico. The upper head-waters of the Dolores River support a viable native cutthroat trout fishery. Silver Creek has little aquatic life because of the heavily mineralized water below the mines; however, CDOW has stocked native cutthroat trout approximately two miles above Rico in Silver Creek and they are doing relatively well (CDOW 1994b).

4.4.3 Environmental Threat

The environmental threat is used to evaluate the threat associated with the actual or potential release of hazardous substances from a site to sensitive environments specified by state and federal statutes. While no National Wetland Inventory maps are available for the upper Dolores River area, it may be assumed that a limited amount of emergent vegetation exists within the specified fifteen-mile downstream target distance limit. The 1984 EPA sampling effort did not identify wetlands or critical habitats within one mile of the site (EPA 1984b). A significant montane riparian forest can be found on the east bank of the Dolores River within four downstream miles of the site area (refer to Section 4.2.1 for more discussion). Another montane riparian forest community (*Populous augustifolia/Cornus sericea*) occurs along the Dolores River approximately fifteen miles downstream from the R-A site. This natural community is ranked very rare globally and in Colorado (CNHP 1994).

Federally listed threatened and endangered aquatic species that potentially use the Dolores River include the Colorado squawfish (*Ptychocheilus*), the Humpback chub (*Gila cypha*), the Bonytail chub (*Gila elegans*) and the Razorback sucker (*Xyrauchen texanus*). Federal candidate species include the Flannelmouth sucker (*Catostomus latipinnis*), the Roundtail chub (*Gila robusta*) and the Colorado River Cutthroat Trout (*Oncorhynchus clarki pleuriticus*) (FWS 1994a; FWS 1994b).

4.4.4 Surface Water Pathway Specific Data Gaps

After performing an analysis of all potential site-related sources and associated receptor targets, URS identified the following data gap with regard to the surface water pathway:

- Determination of whether proximal impacted wetlands are present on the Dolores River.

4.5 SOIL EXPOSURE PATHWAY

The soil exposure pathway was evaluated based on the containment of on-site sources and the presence of observed contamination to both on- and off-site soils. No soil sampling has been conducted at the R-A site.

4.5.1 Target Populations

4.5.1.1 Resident Populations

There are no known residents living on the R-A site or within 200 feet of source areas at the R-A site (USGS 1960). The site is inactive; therefore, no workers are on-site.

4.5.1.2 Nearby Populations

Based on census data for the town of Rico, the Rico division and Dolores County, approximately 123 people reside on, or live within 200 feet of, contaminated soil areas (USDOC 1990; USGS 1960). There are no restrictions to access of source materials on the site. Access roads lead to mine adits, mills, tailings and ponds with no gates or fencing (EPA 1984b). ~~The R-A site is in a National Forest with high recreational use.~~ Most of the mining properties in the R-A region were originally patented and are now on private property with approximately 2500 acres combined under one ownership. The R-A area is situated within the San Juan National Forest with small public land parcels mixed within the private mining properties. The area receives high recreational use.

4.5.1.3 Terrestrial Sensitive Environments

The endangered Black-footed Ferret and Bald Eagle may utilize the R-A area. The proposed endangered Southwestern Willow Flycatcher and threatened Mexican Spotted Owl also may be found in the Rico area (FWS 1994a; FWS 1994b). The federal candidate species North American wolverine, Black Tern and Northern Goshawk may utilize the site area as habitat (FWS 1994a; FWS 1994b). Several montane riparian sensitive communities are also found in the area (CNHP 1994).

4.5.2 Soil Exposure Pathway Specific Data Gaps

After evaluating all potential site sources and associated nearby population targets, URS has identified the following data gaps with regard to the soil exposure pathway:

- ~~No source sampling has been conducted at the R-A site; and~~
- No residential soil sampling has been conducted at the R-A site.

Ecology and Environment, Inc. (E&E). 1984c. Report of Sampling Activities at Rico-Argentine Mine, Rico, Colorado. Prepared by Margaret Babits. December 21, 1984.

Ecology and Environment, Inc. (E&E). 1985. Analytical Results for Rico-Argentine Mine, Rico, Colorado. Prepared by Meg Babits. July 29, 1985.

Jahnke, Mary. 1994. Personal communication with local resident. May 18, 1994.

Office of the Federal Register. 1990. National Archives and Records Administration. December 14, 1990, Code of Federal Regulation (CFR) 40, Part 300, "Hazard Ranking System (HRS) for Uncontrolled Hazardous Substance Releases." Appendix A of the National Oil and Hazardous Substances Release Contingency Plan; Final Rule, pp. 55 FR51537-51667.

State of Colorado, Department of Health (CDH). 1988. Application for Transfer and Acceptance of Terms of a Colorado Permit. July 26, 1988.

State of Colorado, Department of Health, Water Quality Control Commission (WQCC). 1993. Classifications and Numeric Standards for San Juan River and Dolores River Basins. Effective October 30, 1993.

State of Colorado, Department of Health, Water Quality Control Division (WQCD). 1994. Personal communication with Kathleen Reilly, Wellhead Protection Program. April 1, 1994.

State of Colorado, Department of Health, Water Quality Control Division (WQCD). 1993. ~~Letter fr. Jim~~ 'Industrial Wastewater Inspection Report by Jim Horn, District Engineer. May 5, 1993

State of Colorado, Department of Natural Resources, Bureau of Mines (BOM). 1915. Inspectors Daily Report, by District 4 Inspector Samual Treais to Commissioner of Mines Fred Carroll. July 3, 1915.

State of Colorado, Department of Natural Resources, Bureau of Mines (BOM). 1939a. Inspectors Report prepared by District No. 4 State Mine Inspector D. C. McNaughton. April 15, 1939.

State of Colorado, Department of Natural Resources, Bureau of Mines (BOM). 1939b. Report to Bureau of Mines. March 18, 1939.

State of Colorado, Department of Natural Resources, Bureau of Mines (BOM). 1940. Inspectors Report prepared by District No. 4 State Mine Inspector D. C. McNaughton. May 18, 1940.

State of Colorado, Department of Natural Resources, Bureau of Mines (BOM). 1942a. Inspectors Report prepared by District No. 4 State Metal Mine Inspector D. C. McNaughton. May 27, 1942.

State of Colorado, Department of Natural Resources, Bureau of Mines (BOM). 1942b. Newspaper reports in files. 1941 and 1942.

State of Colorado, Department of Natural Resources, Bureau of Mines (BOM). 1943. Report to Bureau of Mines.

State of Colorado, Department of Natural Resources, Bureau of Mines (BOM). 1971. Information Report by District No. 4 Inspector. June 10, 1971.

State of Colorado, Department of Natural Resources, Bureau of Mines (BOM). 1974. Information Report by District No. 4 Metal Mining Inspector Thomas D. High. December 5, 1974.

State of Colorado, Department of Natural Resources, Division of Mines (DOM). 1975a. Metal and Nonmetal Mine Operator's Annual Report by Orval Jahnke, General Manager for Rico Argentine Mining Corporation. March 1, 1975.

State of Colorado, Department of Natural Resources, Division of Mines (DOM). 1975b. Information Report by District No. 4 Metal Mining Inspector Thomas D. High. July 17, 1975.

State of Colorado, Department of Natural Resources, Division of Mines (DOM). 1980. Information Report by District No. 4 Metal Mining Inspector Joseph W. Davies. October 24, 1980.

kaw

INDEPENDENT TECHNICAL REVIEW COMMENTS

WA Number: 21-8522 Project Number: 41881.41

Project: SIP Rico - Argentina

Assigned Independent Technical Reviewer: Tim Joseph

Document Title/Date: SIP 6/94

Submitted By: Mike Carr Date: 6/1/94
Site Manager

Comment No.: 1, 2, 3 ☐ Deficiency ☒ Recommendation

1. See comments on the text.
2. Clarify the location of the Town of Rico's D.W. intake. pg 13
3. Check the G.W. population in the worksheet. pg 9
4. Remember not to use "area of concern" and "waste" too much as per the SAM.

Corrective Action:

1. Comments addressed & discussed w/ reviewer
2. Added text
3. Done & reviewed w/ reviewer
4. Done

M.V. Carr 6/9/94
Submitted by Date

Comment No.: ☐ Deficiency ☒ Recommendation

The reviewer has identified several potential data gaps. They are listed on yellow sticky notes. Please review and discuss these comments with the reviewer. I.E. no target samples have been collected but this is not considered a data gap.

Corrective Action:

Have added data gaps after discussion w/ reviewer and other staff

M.V. Carr 6/9/94
Submitted by Date

URS
Project No. 41881
Log No. 41.80B1769
☐ Original ☐ Copy

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SCREENING SITE INSPECTION

Rico Argentina
Rico, Colorado

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LIST OF FIGURES

The Rico-Arg scenario in PREscore obtained a score of 50.12 with an assumption of one pound of harvestable fish collected from the Dolores River. ~~However~~ The fact that edible fish are being taken from the river is not totally certain based on conversations with CDOW staff and fishing shops in Durango; however, even without the fish the site scores a 30.20 based on the rare plant community on the banks of the Dolores River, four miles downstream from the R-A site. What-if scenarios assuming additional wetlands did not change the score. but wetlands has been added as a data gap in the event that the rare plant community has ceased to exist. Additional scenarios included on the attached disc include R-Asoil (35.12) which did not include fish poundage but assumed ~~did~~ ~~include~~ 123 residents at Level II soil contamination exposure. With the fish poundage added to the soil exposure, (R-Asofis), the score increased to 53.23.

1.0 INTRODUCTION

URS Consultants, Inc. (URS) has been tasked by the U.S. Environmental Protection Agency (EPA) under the Alternative Remedial Contracts Strategy (ARCS) Contract Number 68-W9-0053 to conduct a Site Inspection Prioritization (SIP) (Work Assignment Number 21-8JZZ) for the Rico-Argentine (R-A) site (CERCLIS ID# COD980952519) located north of Rico, Colorado, 81332. Previous work at the site includes an EPA Potential Hazardous Waste Site - Site Inspection Report (Form 2070-13) compiled by State of Colorado, Department of Health (CDH) personnel in June 1984 and a second Form 2070-13 completed by an EPA contractor, Ecology and Environment (E&E), in November 1984. An EPA surface water and sediment sampling effort was conducted by E&E on November 14, 1985 and an Analytical Results Report (ARR) delivered to the EPA on July 29, 1985. The U. S. Department of the Interior, Bureau of Reclamation (BOR) has conducted yearly surface water and sediment sampling on Silver Creek and the Dolores River from 1989 through 1993 (Ecology and Environment (E&E) 1985; U.S. Environmental Protection Agency (EPA) 1984a; EPA 1984b; U. S. Department of the Interior, Bureau of Reclamation (BOR) 1994). This SIP was assigned to a URS investigator on April 11, 1994.

2.0 OBJECTIVES

The purpose of this SIP is to review existing data for the A-R site and identify whether data gaps exist with respect to the revised Hazard Ranking System (HRS) at the R-A site, and to provide sufficient documentation for the EPA to determine the human health and environmental impacts posed by the R-A site, thus determining the appropriate future course of action.

The specific objectives of this SIP are to:

- Summarize the previous work at the R-A site;
- Identify, quantify (if possible) and characterize wastes attributable to this site;
- Identify waste availability to each migration pathway;
- Identify whether there is a potential for, or actual impact on, receptor targets; and
- Identify relevant data gaps for each migration pathway.

3.0 BACKGROUND

3.1 SITE LOCATION

The R-A site encompasses approximately 75 acres of settling ponds near the east end of Dolores County in the Rico Mountains in the southwestern corner of Colorado (Figure 1). A total of approximately 2,500 acres of mining operations have been consolidated under one ownership (EPA 1984b). The Rico Mountains are a subsidiary group of peaks on the southwest fringe of the San Juan Mountains (U. S. Geological Survey (USGS) 1974). The legal description for the R-A site is the southeast quarter of Section 25, Township 40 N, Range 11 W. The approximate site coordinates are 37° 42' 05" North latitude and 108° 01' 39" West longitude. The site can be reached by proceeding south from Telluride, Colorado on State Highway 145 over Lizard Head Pass to Rico or by proceeding north from Cortez on state Highway 145.

3.2 SITE DESCRIPTION

Site description information included here is taken primarily from EPA; CDH; and State of Colorado, Division of Mines (DOM) file documents. The R-A site is an inactive mining operation located in portions of two drainages, Silver Creek and the Dolores River, above the town of Rico. Silver Creek and the Dolores River have their confluence within the town of Rico (Figures 1 and 2). The underground mine workings are interconnected and the drainage water from the mines is sent to the St. Louis Tunnel Adit ~~and~~ where it is discharged into a slaked lime water treatment plant and then a series of 18 settling ponds before discharging into the Dolores River. The R-A complex has had a National Pollutant Elimination Discharge System (NPDES) permit (#CO-0029793) for this discharge system since 1976 but has been frequently in violation of permit standards (U.S. Environmental Protection Agency, Water Management Division (WMD) 1994). The discharge averages approximately 1.1 to 1.5 million gallons per day (MGD) (WMD 1994). The discharge has also been regulated under the Colorado Pollutant Discharge Elimination System (CPDES). The St. Louis Tunnel Adit is approximately three quarters mile to the north of Rico (USGS 1960). ~~This area is also the location of~~ Near the St Louis Tunnel Adit on the Dolores River are also a large, inactive sulfuric acid plant and two cyanide heap leach basins. Approximately one mile northeast up Silver Creek are located another series of tailings piles and settling ponds, the Blaine Tunnel and the Rico-Argentine Mill (Figure 2). The entire Rico area has been heavily mined in the past. The R-A region is primarily Bureau of Land flotation mills in Salt Lake City until 1926 at which time a 250-ton custom mill was built at Rico by the International Smelting Company, a subsidiary of Anaconda Mining Company. The RAMC, working the south side of Silver Creek, was one of the major producers during this period. Base-metal peak production occurred in 1927, by 1928 the custom mill in Rico had shut down, in 1929 the Depression drove down the economy and by 1932 production has ceased (USGS 1974).

Mining resumed in 1934 and fluctuated until 1939 when RAMC finished a 135-ton flotation mill and started steady production (BOM 1939a; BOM 1939b). The RAMC obtained control of most of the mining properties in the district during this time (BOM 1949a; USGS 1974). By 1940, the mill capacity was up to 150 tons (BOM 1940; USGS 1974). In the early 1940s, RAMC began selling pyrite ore to vanadium producers in Utah (BOM 1942b; BOM 1943). The narrow-gauge railroad line was abandoned in 1951 for economic reasons. By 1955, the long crosscut from the Argentine shaft on Silver Creek to the St. Louis tunnel on the Dolores River was finished, lowering the water level in the Silver Creek workings by 450 feet. Also in 1955, RAMC completed and put in operation a plant for the production of sulfuric acid from pyrite near the St. Louis Adit. Nine years later, the plant was put on standby basis due to a cutback in the uranium program in which the sulfuric acid was used (USGS 1974).

On May 26, 1971, all RAMC mining operations were ceased, equipment below the 500 level removed and the lower levels allowed to flood and drain through the St. Louis Tunnel (BOM 1971). In 1973, RAMC sampled the old mine dumps and began work on a 300 foot by 500 foot leaching pad next to the old sulfuric acid plant. A precipitation and recovery process using three pounds of cyanide per ton of water was begun on a pile containing approximately 100,000 tons of raw ore. Early in the start-up, an overflow of the leach reagent occurred with an unknown amount released to the Dolores River (BOM 1974). Approximately $1,200,000 of production was obtained (State of Colorado, Division of Mines (DOM) 1975a). In 1975, an additional leach pad containing 55,000 tons of raw ore was constructed in a settling pond originally used by the acid plant. A Hypalon liner was placed in this pad and a 3% to 4% cyanide solution used with added lime (DOM 1975b).

The Anaconda Copper Company (ACC) acquired the Rico Argentine Mine property from RAMC in 1980. ACC began a surface drilling program for exploration, mostly of molybdenum (Anaconda ~~Copper~~ Minerals Company (ACC) 1994; DOM 1980; DOM 1981). ACC continued with both surface and underground exploratory drilling over the next several years (ACC 1994; DOM 1982; DOM 1983). ACC also built a water treatment plant at the St. Louis Tunnel discharge and carried out several other environmental efforts such as pond stabilization, adit plugging, and capping of wells (ACC 1994; WMD 1994).

In 1984, an EPA Potential Hazardous Waste Site - Site Inspection Report (Form 2070-13) was completed after a site visit by two CDH geologists. Minimal information is contained in the report although it did discuss a NPDES permit issued to RAMC in 1976 with a compliance schedule (EPA 1984a). This permit has been renewed several times and currently is in effect through September 30, 1995 (WMD 1994). The report also stated that the CDH Water Quality Control Division (WQCD) issued a Notice of Violation (NOV) and a Cease and Desist Order (CDO) in 1980 because of RAMC problems in meeting compliance limitations (EPA 1984a). The NOV and CDO were amended on December 17, 1981, and specified exceedances of zinc and copper standards. This led to the development of a water treatment system using slaked lime at the St. Louis Tunnel Adit (WMD 1994). In October 1984, E&E's Field Investigation Team (FIT) conducted a site visit which confirmed that ACC had started water treatment operations using slaked lime at the St. Louis Adit. E&E personnel also found two piezometer wells, between the Silver Creek tailings ponds and Silver Creek, apparently installed in 1981 by Dames and Moore as part of a geotechnical study on the stability and potential expansion of the ponds (E&E 1984a). A sampling plan was issued on October 18, 1984 (E&E 1984b). Field sampling was conducted on November 14, 1984 and involved the collection of nine surface water samples and eight sediment samples. No source or target samples were collected during the sampling effort. Field personnel noted that leachate appeared to be migrating from the settling ponds ~~on~~ above Silver Creek to ~~the surface water~~ Silver Creek. They also noted that both surface water bodies contained iron-stained cobbles (E&E 1984b; E&E 1984c; EPA 1984b). An ARR was issued by E&E in 1985. The ARR concluded that the surface water samples contained elevated manganese concentrations and that the sediment samples contained arsenic, cadmium, copper, iron, lead, manganese and zinc at much higher concentrations than upgradient samples (E&E 1985). A NOV was issued by CDH to ACC for cadmium permit standard violations in November and December 1984 (WMD 1994).

In 1988, ACC sold their holdings in the Pioneer District, approximately 2,500 acres, to the Rico Development Corporation (RDC), a division of Crystal River exploration and Production Company (ACC 1994; CDH 1988; EPA 1984b; WMD 1994). Fish tissue samples collected from September 1989 through March 1991, at reservoirs approximately 40 miles downstream from the R-A site, were found to contain high levels of mercury (E&E 1991a; E&E 1991b). The U.S. Department of the Interior, Bureau of Reclamation (BOR) began surface water and sediment sampling in 1989 along the upstream reaches of the Dolores River and its tributaries to determine potential sources of the mercury. This sampling has continued periodically every year through 1993. The sediment data shows Silver Creek to be the major source of heavy metals, including mercury, in the upper Dolores River basin. The April 1992 water samples indicate that, in addition to Silver Creek, there are numerous sources of mercury in the upper Dolores River basin and many of them are located well downstream from Silver Creek. The study also shows metal loading from various mine drainages which contribute to contamination of the Dolores River (BOR 1994). ~~yearly to the present time and, while not showing attribution of mercury to the Rico area, has shown metals loading occurring, primarily to Silver Creek (BOR 1994).~~

Since RDC obtained the property from ACC, violations of the discharge permit have continued. Another NOV and CDO were issued in 1990 for violations of lead and silver standards. Unpermitted discharge from the Blaine Tunnel on Silver Creek also was reported in 1990 ~~with a~~ which resulting began construction of a concrete dam ~~placed~~ by RDC ~~into~~ to plug the Blaine Tunnel (WMD 1994). The St. Louis Tunnel discharge has also repeatedly failed the Whole Effluent Toxicity (WET) testing required by the NPDES permit. An additional NOV was filed in 1993 for silver violations and a notation made about wastewater flowing into the old cyanide basins in which the old Hypalon liners are visibly weathered and torn. In 1994, the permit violations have included silver, lead and zinc (WMD 1994); WQCC 1993).

In April 1994, the property was sold to Azure, Inc., a development company from Phoenix, Arizona, who is looking into real estate development possibilities. Azure, Inc. has retained Walsh and Associates as a consultant (~~Theile~~ 1994).
stet ~~Azure, Inc.~~

3.4 SITE GEOLOGY

Detailed information about the geology of the R-A site area can be found in "Geology of the Rico Mountains, Colorado" by Whitman Cross and Arthur Coe Spencer (USGS 1900); "Geologic Atlas of the United States, Rico Folio" by Whitman Cross and F. L.

Ransome (USGS 1905) and "Geology and Ore Deposits of the Rico District, Colorado" by Edwin T. McKnight (USGS 1974).

The geology of the Rico Mountains is extremely complex with the dominant structure of the district a faulted dome centered near a monzonite stock. A central faulted horst block of Precambrian rock has been uplifted about 6,000 feet. The lower slopes of the Rico district are generally covered by debris from the hillsides from wash, talus and landslide processes (State of Colorado, Geological Survey (CGS) 1985; USGS 1900; USGS 1905; USGS 1974).

Bedrock in the district ranges from Precambrian to Permian. Precambrian rocks include older greenstone and metadiorite and later Uncompaghre Quartzite which is at least 1,000 feet thick. Overlying the Precambrian is Devonian age Ouray Limestone succeeded by Mississippian Leadville Limestone with a combined thickness of approximately 169 feet. Both formations have been metamorphosed by the monzonite intrusive body. Approximately 2,800 feet of Hermosa Formation (Middle Pennsylvanian age) is the next youngest strata. The Hermosa Formation is of great economic interest because most of the ore deposits of the district occur in it, particularly in its limestone beds. The Hermosa is overlain by the Rico Formation (300 feet thick) of Middle and Late Pennsylvanian age. The highest formation exposed in the district is the Cutler Formation of Early Permian age with at least 2,800 feet of strata remaining (USGS 1900; USGS 1905; USGS 1974).

At the end of the Mesozoic Era, the sedimentary sequence was intruded by sills and dikes of hornblende porphyry. At a later stage, the sequence was intruded by a less silicic stock of monzonite. Channelized metamorphism may extend up to 1.7 miles from the stock (USGS 1974).

The ore deposits of the district consist of (USGS 1905; USGS 1974):

- Massive sulfide replacement deposits in the limestones of the Hermosa Formation;

- Contact metamorphic deposits of sulfides and iron oxides inn limestones of Ouray, Leadville and Hermosa Formations;

- Veins on fractures and small faults in Hermosa sandstones and arkoses; and

- Replacement deposits in residual debris in lower the Hermosa Formation (the rich blanket deposits).

Don't use "aquifer of concern" as per PAT discuss contaminant or targets in info "aquifer of concern"

3.5 SITE HYDROGEOLOGY

~~The aquifer of concern at the R-A site is the shallow alluvial aquifer.~~ No hydrogeologic studies of this area were located during this investigation; thus, the following discussion is based on assumptions from available geologic studies. The principal aquifer in the R-A site area is the shallow alluvial aquifer.

As stated in Section 3.4, Site Geology, the valley sides and bottom are thickly covered by detritus from weathering and erosion. This material forms a shallow unconfined aquifer through which the streams and rivers of the region flow. Hydraulic conductivity is assumed to be fairly high (10^{-2} centimeters per second (cm/s)) (Office of the Federal Register 1990). The direction of shallow groundwater flow is estimated to be south along the Dolores River and southwest along Silver Creek (EPA 1994). Some local areas, such as near tailings piles, may seal themselves through the sifting of fine-grained material (BOR 1994). The shallow aquifer is heavily mineralized in most cases. The State of Colorado, Division of Highways, drilled a well on the south end of the town of Rico for water supply for a maintenance shop but had to abandon it after a couple of years due to heavy mineralization in the pipes (State of Colorado, Department of Transportation (CDOT) 1994; State of Colorado, Office of the State Engineer (CSE) 1994).

direction of flow

Deeper bedrock aquifers exist in the various limestone strata in the older formations and in the fractures in the formations. Several of the old exploratory drill holes on the Dolores River portion of the site, flowed water and had to be capped (ACC 1988; ACC 1994). Groundwater reaches the surface in the form of several seeps and springs found in the area and a number of these appear to be geothermal in nature. One drill hole is used by locals to supply hot water to a pool the locals use to soak in (Jahnke 1994). Many of the springs contain carbonic acid gas and sulphureted hydrogen (USGS 1905), some springs are calcareous due to the high carbonate of lime contained by many of the geologic formations and several springs are iron-bearing and have left local deposits of iron oxide (USGS 1900). In the vicinity of the R-A complex, deep groundwater has been allowed to flow thru the abandoned workings and is discharged through the St. Louis Tunnel Adit to a small treatment system (EPA 1984b; UHD 1994).

3.6 SITE HYDROLOGY

The Dolores River and its Silver Creek tributary are the major surface water bodies ~~of concern~~ in the R-A site area. The Dolores River flows to the south past the St. Louis Tunnel Adit, the old sulfuric acid plant, the cyanide heap leach basins, and numerous tailings piles and settling ponds (USGS 1960). Silver Creek flows to the southwest and is the source of the town of Rico's drinking water. Below the drinking water diversion, Silver Creek flows past several mine workings including the Blaine Tunnel and the Rico-Argentine Mill and settling ponds. Silver Creek flows through the town of Rico before joining the Dolores River on the western edge of Rico. The only flow rate data is from a gage on the Dolores River at a point four miles below Rico. At this station the 41-year annual mean flow rate is 136 cubic feet per second (cfs) and the upstream drainage basin encompasses 105 square miles (mi^2) (USGS 1993). The Dolores River is not used as a source of municipal drinking water; however, there are twelve listed diversions within fifteen downstream miles of the R-A site. ~~One of these is listed as multiple use with partial domestic water supply (this diversion is the St. Louis Tunnel) and~~ The surface water diversions others are used for irrigation, stockwatering, industrial, recreation, fire and other ~~uses~~ purposes (CSE 1994).

The St. Louis Tunnel is the only diversion with domestic use listed, as well as industrial and stockwatering; however, it is doubtful that any domestic use actually occurs from this water source.

3.7 SITE METEOROLOGY

The R-A site is located in a semiarid climate zone. The mean annual precipitation, as totaled from the University of Delaware (UD) database, is 12.8 inches. The net annual precipitation as calculated from precipitation and evapotranspiration data obtained from the UD is 4.1 inches (University of Delaware (UD) 1986). The 2-year, 24-hour rainfall event for the site is approximately 1.5 inches (Dunne and Leopold 1978).

4.0 PRELIMINARY PATHWAY ANALYSIS

This following analysis will consider potential site impacts on the air pathway, groundwater pathway, surface water pathway, and soil exposure pathway utilizing HRS guidelines (Office of the Federal Register 1990).

4.1 SITE SOURCE QUANTITY AND CHARACTERISTICS

Source areas at the R-A site include the estimated 75 acres of tailings piles and settling ponds along both the Dolores River and Silver Creek (EPA 1984b). The St. Louis Tunnel discharge of 1.1 to 1.5 MGD is also considered a R-A source (WMD 1994).

The source areas are ~~An~~ estimated to contain 400,000 tons of material ~~waste exists~~ at the R-A site (EPA 1984b). A number of sampling efforts have been conducted at the site. These include an ACC contractor from 1980 through 1983, EPA-sponsored sampling in 1984 and BOR sampling from 1989 through 1993. These sampling efforts focused on surface water and sediment analyses (EPA 1984b; E&E 1985; BOR 1994). No characterization of the tailings piles, tailings ponds or settling ponds has been located in the file search; however, review of geologic studies, mining texts and personal conversations with employees of the old mining companies, leads to an assumption that cyanide and the heavy metals typically associated with sulfide ores would be the contaminants of concern in the source areas. No mention of the use or storage of any other hazardous wastes was found in the files.

From reports in EPA, CDH and BOR files, it is assumed that all tailings piles, tailings ponds and settling ponds were constructed with native material without liners or runon/runoff controls. The two cyanide heap leach pads that were built did incorporate Hypalon liners and overflow berms but these have not been maintained to the present time (BOM 1974; DOM 1975b, WMD 1994).

4.2 AIR PATHWAY

No ambient air monitoring has been performed at the R-A site. The air pathway was evaluated on the potential to release.

4.2.1 Target Populations

Approximately 92 people live in the town of Rico and 123 residents are listed in the U.S. Census Bureau's Rico division which is within the four-mile target distance limit (U.S. Department of Commerce (USDOC), Bureau of the Census 1990). No other residents were located. The federally listed threatened and endangered Bald Eagle (Haliaeetus leucocephalus), Peregrine falcon (Falco peregrinus) and Mexican spotted owl (Strix occidentalis lucida) potentially inhabit the area (U.S. Department of the Interior, Fish and Wildlife Service (FWS) 1994). Federal candidate species North American wolverine (Gulo gulo luscus) and Northern goshawk (Accipiter gentilis) may also inhabit the Rico area (FWS 1994).

The nearest residents appear to be approximately six-tenths of a mile upgradient from the St. Louis Tunnel (USGS 1960). It is estimated that eight people reside between one-half and one mile from site sources and an additional 70 between one-half mile and one mile (USDOC 1990, USGS 1960)

No National Wetland Inventory maps have yet been prepared for this area (Earth Science Information Center (ESIC) 1994). The EPA's 1984 sampling effort did not find wetlands within one mile of the site (EPA 1984b); however, it is reasonable to assume that forested and emergent wetland vegetation exists within the specified four-mile target distance limit. A significant community of montane riparian forest (Populous augustifolia-Picea pungens/Alnus incana) can be found on the east bank of the Dolores River within four miles of the site. This natural community is ranked rare to uncommon both globally and in Colorado (Colorado Natural Heritage Program (CNHP) 1994).

4.2.2 Air Pathway Specific Data Gaps

After performing an analysis of all potential sources on site, URS was not able to identify areas where additional data acquisition is required.

4.3 GROUNDWATER PATHWAY

The groundwater pathway was evaluated on the potential to release. No groundwater monitoring data is available. The CPDES permit monitoring does show a release of silver, lead and zinc from groundwater drainage discharging from the St. Louis Tunnel (WMD 1994).

4.3.1 Target Populations

The population potentially impacted by groundwater contamination consists of the users of three wells listed as household use by the Colorado State Engineer (CSE 1994). Two of these wells are located approximately one-half mile upgradient of the St. Louis Tunnel Adit and it's associated ~~settling ponds~~ sources on the Dolores River. The third domestic well is at the south end of the town of Rico, approximately one and one-half miles downgradient of the source areas and below the confluence of Silver Creek and the Dolores River (CSE 1994; USGS 1960). Approximately six people use these wells, possibly for drinking water (USDOC 1990). Jahnke 1994;

for a drinking water source

The state engineer lists the well depth as 160 feet; however, the owner was unsure what ~~the screened~~ depth the screened interval was (CSE 1994; Jahnke 1994)

4.3.2 Wellhead Protection Area

The R-A site does not lie within a state or federally designated wellhead protection area (State of Colorado, Department of Health, Water Quality Control Division (WQCD) 1994).

4.3.2.1 Resource Use

Groundwater within the specified four-mile target distance limit is limited to the three household wells discussed in Section 4.3.1 and one industrial use well owned by the Rico Development Corporation (CSE 1994).

4.3.3 Groundwater Pathway Specific Data Gaps

After performing an analysis of all potential site-related sources and associated receptor targets, URS has been unable to identify areas where additional data acquisition is required.

4.4 SURFACE WATER PATHWAY

The surface water pathway was evaluated on observed release by chemical analysis.

4.4.1 Drinking Water Threat

The drinking water threat is used to evaluate the threat associated with the actual or potential release of hazardous substances from a site to drinking water resources. There are no municipal drinking water diversions within fifteen downstream miles from the R-A site on the State Engineer's Water Rights Report. There are twelve total diversions on the Dolores River, one of which includes domestic use in its multiple use codes. This water right is listed as the St. Louis Tunnel and includes industrial and stockwatering as its other uses (CSE 1994).

¶ The ~~city~~ town of Rico obtains its drinking water from a diversion on Silver Creek well above the mining impacts. The water is treated through infiltration galleries and chlorinated (E&E 199[illegible]).

4.4.2 Human Food Chain Threat

The human food chain threat is used to evaluate the threat associated with the actual or potential release of hazardous substances to surface water containing human food chain organisms. ACC contractors found decreased aquatic life in the Dolores River in the 1980s, but could not attribute it to the site (EPA 1984b). A number of federally listed threatened and endangered fish may utilize the surface water habitat as discussed in the next section under Environmental Threat. The presence of harvestable sizes of game fish has not been confirmed. The State of Colorado, Division of Wildlife (CDOW) conducted fish studies on two 500 foot reaches of the Dolores River near Spruce Creek, one and one-half miles below Rico, in 1982 and found three rainbow trout between ten and twelve inches in length and one small brown trout. The CDOW performed habitat improvement in the form of instream boulders and check dams which led to increased populations of brown trout between five and six inches in length in 1983. By 1984, CDOW fish sampling showed greatly increased populations of ten to twelve inch brown trout and slightly increased populations of rainbow and brook trout (State of Colorado, Division of Wildlife (CDOW) 1994). Local bait and tackle shops confirmed the presence of harvestable game fish in the upper reaches of the Dolores River (Duranglers 1994).

4.4.3 Environmental Threat

The environmental threat is used to evaluate the threat associated with the actual or potential release of hazardous substances from a site to sensitive environments specified by state and federal statutes. While no National Wetland Inventory maps are available for the upper Dolores River area, it may be assumed that a limited amount of emergent vegetation exists within the specified fifteen-mile downstream target distance limit. The 1984 EPA sampling effort did not locate existing wetlands within one mile of the site (EPA 1984b). A significant montane riparian forest can be found on the east bank of the Dolores River within four downstream miles of the site area (refer to Section 4.2.1 for more discussion). Another montane riparian forest community (Populous augustifolia/Cornus sericea) occurs along the Dolores River approximately fifteen miles downstream from the R-A site. This natural community is ranked very rare globally and in Colorado (CNHP 1994).

Federally listed threatened and endangered aquatic species that potentially use the Dolores River include the Colorado squawfish (Ptychocheilus), the Humpback chub (Gila cypha), the Bonytail chub (Gila elegans) and the Razorback sucker (Xyrauchen texanus). Federal candidate species include the Flannelmouth sucker (Catostomus latipinnis) and the Roundtail chub (Gila robusta) (FWS 1994).

Resource Use?

4.4.4 Surface Water Pathway Specific Data Gaps

After performing an analysis of all potential site-related sources and associated receptor targets, URS has ~~determined that no significant data gaps exist.~~ identified the following data gaps with regard to the surface water pathway:

- No source characterization sampling has been conducted at the R-A site/pond
- Confirmation of harvestable quantities of fish being collected from the Dolores River; and
- Determination of existence of impacted wetlands on the Dolores River

4.5 SOIL EXPOSURE PATHWAY

The soil exposure pathway was evaluated on the potential to release. No soil sampling has been conducted at the R-A site.

4.5.1 Target Populations

4.5.1.1 Resident Populations

There are no known residents living on the R-A site or within 200 feet of source areas at the R-A site (USGS 1960). The site is inactive; therefore, no workers are on-site.

4.5.1.2 Nearby Populations

Based on census data for the town of Rico, the Rico division and Dolores County, approximately 84 people live within one mile of the R-A site (USDOC 1990; USGS 1960). There are no restrictions to access of source materials on the site. Access roads lead to mine adits, mills, tailings and ponds with no gates or fencing (EPA 1984b). The R-A site is in a National Forest with high recreational use.

4.5.1.3 Terrestrial Sensitive Environments

The federal candidate species North American wolverine may utilize the site area as habitat (FWS 1994). Several montane riparian sensitive communities are also found in the area (CNHP 1994).

4.5.2 Soil Exposure Pathway Specific Data Gaps

After evaluating all potential site sources and associated nearby population targets, URS has ~~determined that no significant~~ data gaps ~~exist~~.
identified the following data gaps with regard to the soil exposure pathway:
- No source sampling has been conducted at the R-A site; and
- ~~Lack of soil samples~~ No soil sampling has been conducted at the R-A site.

5.0 SUMMARY

The R-A site is an inactive mining area which began operations over 100 years ago as a silver producer. In later periods of operation, base-metal production from sulfide ores and sulfuric acid from pyrite ores were the major goals of the mining operations. The site exists in two areas; The Rico-Argentine Mill, mines and associated tailings piles and ponds on Silver Creek and a sulfuric acid plant, cyanide heap leach pads and settling ponds on the Dolores River. Cyanide heap leaching has been used in two lined ponds with at least one minor release of leachate. All mine water drainage has been routed through underground workings to discharge from the St. Louis Tunnel Adit on the Dolores River. The discharge is treated with slaked lime and is under a Colorado Pollutant Discharge Elimination System permit with input from the EPA's NPDES division. The permit limits have been continuously violated with at least two Notice of Violation and Cease and Desist Orders issued by CDH.

The nearest residents are approximately three-quarters of a mile from the site. There are no restrictions to access to the site. Approximately six residents potentially use groundwater as a drinking water source. Several federally listed threatened and endangered species potentially use the area or exist within the specified target distance limits. Harvestable game fish are taken from the Dolores River within the fifteen-mile downstream target distance limit, but the quantity of fish taken from the river is unknown.

During this evaluation, URS was able to identify the following significant data gaps which exist for the R-A site:

- No source characterization has been conducted (air, surface water and soil exposure pathways);
- Confirmation of harvestable quantities of fish being collected from the Dolores River (surface water pathway);
- Determination of existence of wetlands along the Dolores River (surface water pathway); and
- No soil sampling has been conducted at the R-A site

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FIGURE 1

Radius of Influence Map

Area

HIGHLIGHTS:

A) IS THERE QUALITATIVE OR QUANTITATIVE EVIDENCE OF A RELEASE TO AIR, SURFACE WATER, GROUNDWATER, OR SURFACE SOIL? DESCRIBE BRIEFLY.
More detail in items GW-1 (for groundwater pathway), SW-5 (for surface water pathway), A-1 (for air pathway), and SE-1 (for soil exposure pathway).

Yes, to surface water. Surface water samples collected for NPDES monitoring repeatedly detect violations of permit standards for several metals. Surface water and sediment samples collected from 1989 through 1993 by the Bureau of Reclamation show metals loading to the drainages.

B) IS THERE EVIDENCE OF AN **IMPACTED** TARGET POPULATION? DESCRIBE.

Pathway	Target None/target Size	Brief Description	More Discussion In
Groundwater	Public drinking Water supply None Domestic drinking Water supply 6	Three wells within a four-mile radius are listed as household use. No impacts noticed by users.	Section 4.3
Surface Water	Drinking water None Fishery Yes Sens. env. N/A	CDOW improved aquatic habitat in 1982 which has increased trout populations to harvestable sizes.	Section 4.4
Soil Exposure	People within 200' None Terrestrial sens. env. N/A	Federal candidate species and state species of concern potentially exist in site area.	Section 4.5
Air	Population None	No air monitoring has been conducted.	Section 4.2

SITE INFORMATION

G-1. Directions to the site (from nearest easily recognized point).

From Telluride, Colorado, proceed south on State Highway 145, over Lizard Head Pass, approximately 30 miles.

G-2. Are there other potential sources in the neighborhood to be aware of as the site is evaluated? eg. Is the site in an industrial area, near a railroad, along a highway? Are sources with similar contaminants to this site in the vicinity?

No. Site area is heavily mined, site sources are major sources in the area.

Source of information: CDH Files; EPA Files; USGS [illegible]

Background/Operating History

G-3. Describe the operating history of the site:

Early mining began in 1861. Silver production peaked in the 1890s and base-metal ore production peaked in 1927. A sulfuric acid production plant operated from 1955 through 1964. All mining operations ceased in 1971. Cyanide heap leaching occurred from 1973 through the late 1970s. Anaconda Minerals Company owned the property from 1980 to 1988 and explored for molybdenum. Rico Development Corporation owned the property from 1988 to April 1994 when they sold their interests to Azure, Inc., from Phoenix, Arizona. A NPDES permit was obtained in 1976. Frequent violations of the permit have occurred. BOR sampling shows loading of heavy metals to the adjoining surface water drainages.

Source of information: ACC 1994; BOM 1915; BOM 1939a; BOM 1939b; BOM 1940; BOM 1942b; BOM 1943; BOM 1949a; BOM 1974; CDH 1988; DOM 1975a; DOM 1975b; DOM 1980; DOM 1981; DOM 1982; DOM 1983; E&E 1984a; E&E 1984b; E&E 1985; E&E 1991a; E&E 1991b.

G-4. Describe site and nature of operations (property size, manufacturing, waste disposal, storage etc.):

See #G-3. Approximate site acreage is 2,500 acres. Sources cover approximately 75 acres. Tailings piles, tailings ponds and settling ponds typical of hardrock mining comprise the source areas.

Source of information: EPA 1984a; EPA 1984b; USGS 1905; USGS 1974; EMD 1994.

G-5. Describe any emergency or remedial actions that have occurred at the site:

None. Anaconda did some environmental work (plugged adits, maintained settling ponds, built water treatment plant) while they owned the property.

M

Source of information: ACC 1994, CDH files, EPA files.

G-6. Are there records or knowledge of accidents or spills involving site wastes? Are there Emergency Response Notification (ERNs) reports for this location?

None.

Source of information: EPA files.

G-7. Describe existing sampling data and briefly summarize data quality (e.g. sample objective, age/comparability, analytical methods, detection limits, QA/QC, validatability):

Sampling of surface water is conducted periodically for the NPDES permit. Methods and QA/QC are unknown. BOR sampling has been conducted yearly to trace mercury and other metals loading in the Dolores River and its tributaries.

Source of information: BOR 1994, WMD 1994.

G-8. Is there any other local, state or federal regulatory involvement? Describe. Include permits, and names of contact individuals within each government organization.

AGENCY	PROGRAM	CONTACT	PHONE	PERMIT
CDH	NPDES	Kathleen Kalamen	692-3603	CO-0029793

G-9. Attach site sketch or schematic. Include all pertinent features including wells, storage areas, underground storage tanks, source areas, buildings, access roads, areas of ponded water. Refer to figure(s) submitted with text of report if appropriate.

Refer to figures 1 and 2.

SOURCE CHARACTERIZATION

WC-1. Describe each source at the site, on Table 1, in terms of source type, containment, size/area/volume/quantity, and substances present. See HRS Tables 2-5 and 5-2 for source descriptions, Tables 3-2, 4-2, 4-8, 5-6, 6-3, and 6-9 for containment.

WC-2. Briefly describe how waste quantity was estimated (eg. historical records or manifests, permit applications, air photo measurements, etc.):

EPA's sampling team in 1984 estimated the total size and amount of source material on the site.

Source of information: EPA 1984a; EPA 1984b.

WC-3. Describe any restrictions or barriers to accessibility of on-site sources.

None.

Source of information: 1984b.

GROUNDWATER CHARACTERISTICS

GW-1. Any positive or circumstantial evidence of a release to groundwater? Describe.

Yes. Surface water and sediment sampling show metals loading to these media. Valley fill and alluvial material form an unconfined aquifer that potentially interacts with mine water discharge and surface water bodies. No specific groundwater sampling has been conducted other than mine discharge for NPDES monitoring.

Source of information: EPA 1984b; USGS 1900; USGS 1905; USGS 1974; WMD 1994.

GW-2. Any positive or circumstantial evidence of a release to drinking water users? Describe analytes, detection limits, background, hits, number of users, locations, QA/QC.

None reported. Three household use wells are within the four-mile target distance limit and serve approximately six residents. Two of these wells are approximately three-quarters of a mile upgradient. The other is approximately one and one-half miles downgradient. All other drinking water sources are surface water diversions from above the site area.

Source of information: CDH files; EPA files; WMD 1994.

GW-3. Briefly describe the geologic setting.

Alluvial material from wash and landslides masks the underlying geology. A shallow unconfined aquifer exists in the alluvial material. The Cutler Formation is the youngest formation exposed at the site and is at least 2,800 feet thick. Fractures in bedrock forms a deeper aquifer. Geothermal Springs are found in the site area.

GW-4. Describe geologic/hydrogeologic units on Table 2. Give names, descriptions, and characteristics of consolidated and unconsolidated zones beneath the site.

GW-5. Is the site in an area of karst terrain or a karst aquifer?

No.

GW-6. Net Precipitation (per HRS section 3.1.2.2).

4.1 inches.

SURFACE WATER CHARACTERISTICS

SW-1. Mean annual precipitation (per HRS section 4.0.2)= 12.8". If less than 20", then count intermittent channels as surface water.

SW-2. Discuss the probable surface water flow pattern from the site to surface waters:

The tailings piles from the Rico-Argentine Mill are in Silver Creek with tailing ponds apparently draining directly into Silver Creek. The St. Louis Tunnel Adit drains into a slaked lime treatment system and then a series of settling ponds before discharging into the Delores River. This discharge has a NPDES permit.

Source of information: EPA 1984b; WMD 1994.

SW-3. If surface water exists within 2 miles of the site, describe surface water segments within the 15-mile distance limit.

Segment Name	River/Lake/Type	Fresh/Salt Water	Start (mi.)	End (mi.)	Flow In cfs
Dolores River	River	Fresh	0	15	136
Silver Creek	Creek	Fresh	0	.75	ND N/A

Groundwater to surface water distance N/A Angle Θ ____

SW-4. Provide a schematic diagram or simple figure which describes surface water segments, locates targets, identifies flow direction, PPE(s), etc. Refer to figure(s) submitted with text of report if appropriate.

Refer to figures 1 and 2.

SW-5. Any positive or circumstantial evidence of a release to surface water? Evidence of a release by direct observation? Is the source located in surface water? Describe.

Yes. Tailing piles are placed in Silver Creek and tailings ponds are discharging to Silver Creek. Surface water and sediment samplings performed by BOR in Silver Creek and the Dolores River show metals loading occurring. The NPDES monitoring sampling show repeated exceedances of permit standards for metals.

Source of information: BOR 1994, WMD 1994.

SW-6. Any positive or circumstantial evidence of a release to surface water target populations? Describe analytes, detection limits, background, hits, number of users, locations, QA/QC.

No. An ACC contractor in the 1980s found decreased aquatic life in the Dolores River below the site but could not attribute the situation to the site. No target-specific sampling has been conducted at this site.

Source of information: EPA 1984b.

SW-8. Is the site or portions thereof located in surface water? Yes.

Is the site located in the 1 - ‹10 yr floodplain?

›10-100 yr?

›100-500 yr?

›500 yr?

SW-9. Two-year 24-hour rainfall 1.5"

TARGETS

T-1. Discuss groundwater usage within four miles of the site:

There are no municipal wells within the specified four-mile target distance limit. Five wells are listed by the CSE; one owned by the CDOT for wash water in a maintenance shop, one is listed as industrial use and three are listed as household use. Two of the household wells are approximately three-quarters of a mile upgradient and one is approximately three-quarters of a mile downgradient.

Source of information: CSE 1994, USDOC 1990.

T-2. Summarize the drinking water population served via groundwater within four miles of the site:

0 - 1/4 mi	0
1/4 - 1/2 mi	8.0
1/2 - 1 mi	76
1 - 2 mi	18
2 - 3 mi	10 10
3 - 4 mi	10 11

102 123 102 21

Attach calculations for population apportionment in blended systems.

T-3. Identify and locate any of the following surface water targets within 15 miles of the site: drinking water population(s) served by intakes, fisheries, sensitive environments described in Table 4-23 of the HRS, and wetlands as defined in the Federal Register.

Targets	Dist. From Site	SW Body	Flow In cfs	Population Served/Size (Incl. Units)	Contamination Known/Suspected
Montane riparian	4 miles	Dolores River	136	~~N/A~~ ND	Metals
Dolores Fishery	1 mile	Dolores River	136	~~N/A~~ ND	Metals

One surface water diversion is listed as multiple use including domestic. This diversion is the St. Louis Tunnel, actual domestic use is unknown.

T-4. Summarize the population within a four-mile radius of the site:

	Total Pop.	Worker Pop.
on site	0	0
0 - 1/4 mi	0	
1/4 - 1/2 mi	8	
1/2 - 1 mi	76	
1 - 2 mi	18	
2 - 3 mi	0	
3 - 4 mi	0	

T-5. Identify and locate any terrestrial sensitive environments described in Table 5-5 of the HRS.

Potential habitat for federal candidates species, North American Wolverine and Northern Gas Hawk. Potential habitat for federally listed threatened and endangered Bald Eagle, Peregrine Falcon and Mexican Spotted Owl. Potential habitat for montane riparian forest that is ranked very rare globally and in Colorado.

T-6. Describe any positive or circumstantial evidence of a release to air target populations? Of a release by direct observation where target population exists within 1/4 mile of the site? Describe analytes, detection limits, background, hits, number of users, locations, QA/QC.

No air monitoring has been conducted at this site. No observations are available concerning dust from tailings or ponds blowing offsite.

T-7. Identify and locate any potential or known resident soil exposure populations, if present. Describe conditions which lead the researcher to suspect contaminated soil within 200' of residences, if this condition exists.

None known.

TABLE 1
WASTE CONTAINMENT AND HAZARDOUS SUBSTANCE IDENTIFICATION[1]

SOURCE TYPE	SIZE (Volume/Area)	ESTIMATED WASTE QUANTITY	SPECIFIC COMPOUNDS	CONTAINMENT[2]	SOURCES OF INFORMATION
Tailing piles, ponds	75 acres	400,000 tons	Heavy metals, cyanide	None	CDH files; EPA files
Mine Adits		1.5 Million Gallons Per Day	Heavy metals	Lime treatment system	CDHD files

1 Use additional sheets if necessary.
2 Evaluate containment of each source from the perspective of each migration pathway (e.g., groundwater pathway - non-existent, natural or synthetic liner, corroding underground storage tank; surface water - inadequate freeboard, corroding bulk tanks; air - unstabilized slag piles, leaking drums, etc.)

TABLE 2
HYDROGEOLOGIC INFORMATION[1]

STRATA NAME/DESCRIPTION	THICKNESS (ft.)	HYDRAULIC CONDUCTIVITY (cm/sec)	TYPE OF DISCONTINUITY[2]	SOURCE OF INFORMATION
Alluvial Fill	10-40	10^{-2}	None	EPA 1984b; Office of the Federal Register 1990; USGS 1900; USGS 1905; USGS 1974
Bedrock (Cutler and older Formations)	› 2,800	10^{-5}	None	EPA 1984b; Office of the Federal Register 1990; USGS 1900; USGS 1905; USGS 1974

1 Use additional sheets if necessary.

2 Identify the type of aquifer discontinuity within four-miles from the site (e.g., river, strata "pinches out", etc.).

SITE INSPECTION PRIORITIZATION INDEX

1) Site Historical Information

● reports, correspondence, press clippings, interviews, maps, schematics, permits, ownership records, waste characteristics, analytical data

2) Correspondence

3) Field Information

● log books, site access agreements, photographs and negatives, field sampling plan

4) Health and Safety

● site health and safety plan, MSDS

5) General Site Characterization

● geology, hydrology, hydrogeology, meteorology, maps

6) Interpretative or Final Reports

7) Target Information

● ground water users, surface water users, population data, wetlands maps, land use maps, wind roses

8) QA/QC

41881 41-10-B1012 DATE: MAY 25, 1994	FROM: U.S. DEPT. OF AG.	TO: URS	SUBJ: INFO RE NEW OWNERS OF RICO DEVELOPMENT CORP'S HOLDINGS
41881 41-10-B1014 DATE: 1915-1983	FROM: COLORADO BUREAU OF MINES	TO: PUBLIC	SUBJ: INSPECTOR'S DAILY REPORTS/INFORMATION REPORTS/OPERATOR'S ANNUAL REPORTS
41881 41-10-B1013 DATE: 1984-1988	FROM: CDH	TO: PUBLIC	SUBJ: SITE INFORMATION FROM COLORADO DEPT OF HEALTH FILES
41881 41-20-B1027 DATE: JAN 20, 1994	FROM: URS	TO: EPA	SUBJ: LETTER RE CLOSEOUT AND TRANSFER OF FILES
41881 41-30-B1015 DATE: MARCH 1994 NOTES: 40 PAGES	FROM: URS	TO: URS	SUBJ: LOGBOOK #268 (CARR)
41881 41-50-B1016 DATE: SEPT 27, 1993	FROM: CDH	TO: PUBLIC	SUBJ: CLASSIFICATIONS AND NUMERIC STANDARDS FOR SAN JUAN RIVER AND DOLORES RIVER BASINS
41881 41-50-B1020 DATE: 1905	FROM: USGS	TO: PUBLIC	SUBJ: EXCERPTS FORM "GEOGRAPHY AND GENERAL GEOLOGY OF THE RICO QUADRANGLE"
41881 41-50-B1018 DATE: AUG 1974	FROM: U.S. DEPT. OF INTERIOR	TO: PUBLIC	SUBJ: EXCERPTS FROM "GEOLOGY AND ORE DEPOSITS OF THE RICO DISTRICT"
41881 41-50-B1019 DATE: 1900	FROM: USGS	TO: PUBLIC	SUBJ: EXCERPTS FROM "GEOLOGY OF THE RICO MOUNTAINS, COLORADO"
41881 41-50-B1017 DATE: AUG 4, 1975	FROM: STATE OF COLORADO	TO: PUBLIC	SUBJ: RECONNAISSANCE ENGINEERING GEOLOGY REPORT FOR PLANNING DISTRICT 9
41881 41-60-B1028 DATE: MARCH 1994	FROM: URS	TO: URS	SUBJ: CERCLA ELIGIBILITY WORKSHEET
41881 41-70-B1026 DATE: APRIL 6, 1994	FROM: STATE OF COLORADO	TO: PUBLIC	SUBJ: COLORADO WELLS, APPLICATIONS AND RESOURCES/WATER RIGHTS REPORT
41881 41-70-B1025 DATE: 1990	FROM: U.S. CENSUS BUREAU	TO: PUBLIC	SUBJ: HOUSEHOLD, FAMILY AND GROUP QUARTERS CHARACTERISTICS/LAND AREA AND POPULATION DENSITY
41881 41-70-B1023 DATE: MAY & JUNE 1994	FROM: U.S. DEPT OF INTERIOR	TO: URS	SUBJ: INFO RE FEDERALLY LISTED SPECIES NEAR SITE
41881 41-70-B1024 DATE: APRIL 13, 1994	FROM: COLORADO NATURAL HERITAGE PROGRAM	TO: URS	SUBJ: INFO RE SIGNIFICANT NATURAL COMMUNITIES AND RARE, THREATENED OR ENDANGERED SPECIES
41881 41-70-B1022 DATE: JUNE 6, 1994	FROM: STATE OF COLORADO	TO: URS	SUBJ: INFO RE STATE SENSITIVE WILDLIFE SPECIES NEAR SITE
41881 41-70-B1021 DATE: MAY 25, 1994	FROM: U.S. DEPT OF INTERIOR	TO: URS	SUBJ: WATER QUALITY AND SEDIMENT DATA ON THE DOLORES RIVER
41881 41-80-B0662 DATE: OCT 11, 1994 NOTES: 1 VOL	FROM: URS	TO: EPA	SUBJ: REV 0: SITE INSPECTION PRIORITIZATION/RICO-ARGERNTINE, RICO, COLORADO

PROJECT FILE

FILE NAME CLOSEOUT **JOB NUMBER** 41881.41 **FILE NUMBER** ALL

SITE NAME SITE INSPECTION PRIORITIZATION: RICO-ARGENTINE, RICO, COLORADO

SITE MANAGER MICHAEL V. CARR

EPA CLOSEOUT COPY

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\PMO\CLOSEOUT\COVERS.PA:jlk

*

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President and C.E.O.

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Facsimile: (602) 953-6526
Private Fax: (602) 852-0465

U.S. DEPARTMENT OF AGRICULTURE
U.S. FOREST SERVICE
San Juan National Forest
Dolores Ranger District
100 N. 6th, P.O. Box 210
Dolores, Colorado 81323

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213 W. Colorado
Telluride, CO 81435

5/25/94

Mike,

As you requested here is a copy of the business cards of the folks who just bought all of Rico Development Corporation's holdings - Mike Theile would be your contact if you want the specific date the transaction took place. Feel free to call me if you have any other questions.

Nancy McGarigal
303-882-7296

B. of Mines

[redacted] MINES, STATE OF COL[redacted] 356

Inspector's Daily Report.

Dist. No.4..   ...July 3, 1915......

Fred Carroll, Commissioner of Mines,
Denver, Colorado.

Sir:
I have been engaged during the day as follows: filling out mine reports.

Expenses for the day, about $2.00.. for stamps.

*General Information: I heard from pretty good authority that the Rico Argentine Mining Company of Rico has been financed by Utah Capital and will start up in the near future. They have very large bodies of lead, zinc and iron ore. I have visited this property several times. There is a great deal of Utah capital invested in and around Rico, and they look like pretty good mining men to me.

Dolores

URS Project No. 41881
Log No. 41,10,B1014
☐ Original ☐ Copy

Saml Fears
Inspector. Dist. 4

* Under this head, please report all well founded rumors concerning mine operations in your district, such as accidents, new properties starting up, mines closing down, new strikes or matters of general interest to the industry.

EPA CLOSEOUT COPY

B. of Mines

BUREAU OF MINES, STATE OF COLORADO
DAILY REPORT OF INSPECTOR

Nov 7 1915.

Dist. No. 4

FRED CARROLL,
Commissioner of Mines,
Denver.

Dolores

Sir:
I have been engaged during the day as follows:

Traveled from Rico to Ophir

Distance miles. Method of transportation

Expenses for the day, about $ 2 —

*General Information:

Visited the Rico Argentine Mining Co's property this morning. Five men are employed on development. They drove a Cross Cut about 100 feet. cut the Vein and have started a drift on it. This property is an old producer but not of late. J.C. Easton is Manager. I Came to Ophir this afternoon. There does not seem to be much doing here. I will look around tomorrow.

The American Smelting & Refining Co are the only buyers in Rico. All ores are shipped to the Leadville and Garfield Utah plants.

Inspector.

[signature]

*Under this head, report all well founded rumors concerning operations in your district, such as accidents, new properties starting up, mines closing down, new strikes, and matters of general interest to those engaged in the mining industry.

B. of Mines

METAL MINES AND MILLS

County Post Office District

REPORT TO BUREAU OF MINES
STATE OF COLORADO

FOR YEAR NOVEMBER 30 1916 NOVEMBER 30, 1917

Name of Company The **Rico Argentine Mining Co.**

If a Company, fill out this space, otherwise leave it blank.

Incorporated in the State of Utah

Principal office Salt Lake City, Utah. P. O. Address

President F. W. Price

Secretary J. H. Woodmansee

Manager F. W. Price

If a firm or partnership, fill out this space, otherwise leave it blank.

Title of Partnership

Partners' Names P. O. Address

Manager

If neither company nor partnership, fill out this space.

Names of Owners P. O. Address

Corporation Salt Lake City, Utah.

Manager

Patented Ten claims

Total acreage 200 (?)

Unpatented Nine claims

Total acreage 150 (?)

Do you own or lease these claims? Own eight claims balance under bond and lease

If outside Plant or Mill was idle so state

If you lease them, give name and address of company or person from whom leased Syndicate Mining & Milling Co. New York City, N. Y.

If you have given a lease to others for all or part of the property, state the names of the leasing companies, partnerships or individuals:

Name	Manager	P. O. Address
Marmatite Mining & Milling CO.	G. F. Schreiber	Rico, Colo.

Average contents of ore brought to the surface:

Gold	0.02 oz.	Copper	4.0 %	Iron	25%	Tungstic acid	%
Silver	5. oz.	Zinc	2. %	Sulphur	15. %	Uranium oxide	%
Lead	%	Manganese	%	Insoluble	%	Vanadium oxide	%

Molybdenum sulfide % Flourspar (Ca F.) %

Crude ore sold 2,330 tons Concentrates sold tons Milling ore produced tons

Gold or silver bullion produced, value $ 49,529.08

List of buildings, tramways and other surface improvements made during the year $300.

State amount and character of underground development made during year:

Shafts	ft.	Drifts 200	ft.
Winzes	ft.	Crosscuts	ft.
Upraises 50	ft.		

B. of Mines

138

[illegible]

County Dolores, Post Office Rice Cole, District

Name of Mine or Plant

REPORT TO BUREAU OF MINES

STATE OF COLORADO

FOR THE YEAR 1928

Name of Company or Title of Partnership: Rice Argentine Mining Co.

Address of Principal Office: 539 Atlas Black, Salt Lake, Utah.

Names, titles and addresses of officers, partners or owners:
J. W. Frice, President and Manager
539 Atlas Block, Salt Lake City, Utah.
P. B. Hull, Secty-Treas.
539 Atlas Block, Salt Lake, Utah.

If names of claims have been listed in previous reports, only changes, if any, need be given.

Names and numbers of patented claims: Avalanche 1682; 1/4 Humboldt 15233; 1/2 Jas G Blaine 15233; D-P 1890; Blackhawk 2060; Wide Awake 380; Royal Tiger 1190; Little Maggie 1211; Connecting Link 1210; Alleghany 1255; Elliott Millsite 1636B Total acreage

Names of unpatented claims: Ophir; Salt Lake; Sporty; Fraction; Uintah; Wedge; Triangle; Last Chance; Total acreage

Do you own these claims, or do you operate them under lease? own

If you operate under lease, give name and address of company or person from whom leased

If you have given a lease to others for all or part of the property, state the names of the leasing companies, partnerships or individuals:

Name	Manager	P. O. Address

Is the work done by your lessees included in this report?

Have you a mill or reduction works: no If so, what is its character and capacity?

Average contents of products **sold**. (If both crude ore and concentrates are sold, give average contents of each.)

Gold .025 oz.	Copper 1.48 %	Iron 4.6 %	Tungstic acid %
Silver 5.35 oz.	Zinc 22. %	Sulphur 18.6 %	Uranium oxide %
Lead 18.48 %	Manganese %	Insoluble 6.8 %	Vanadium oxide %
Molybdenum %	Fluorspar %		

Crude ore sold 1785 tons Concentrates sold tons Milling ore produced tons

Gold or silver bullion produced, value

List of buildings, tramways, and other surface improvements made during the year

Amount and character of underground development during year: Shafts ft

Winzes ft. Raises 70 ft. Drifts 500 ft. Crosscuts 150 ft.

B. of Mines

STATE OF COLORADO
BUREAU OF MINES
INSPECTOR'S REPORT
TO
JOHN T. JOYCE,
COMMISSIONER OF MINES.

THE ARGENTINE GROUP MINES
Name of Mine or Plant

Dolores County

April 8, 1926.

not Rico Argentine Mining Co. see USGS 1974

THE ARGENTINE GROUP is operated by the RICO MINING and REDUCTION COMPANY, 705 First Natical Bank Bldg., Denver, Colorado, George O. Carpenter, President; Fred G. Farish, Manager, Rico, Colo. Operating under bond and lease. Owner, Swickhimer Estate, Rico, Colo.

In the same unit the company operates the RICO CONSOLIDATED MINES, owner, the Knight Investment Co., Provo, Utah, and the BERTHA S. owned by G. L. Garren, Rico, Colo.

These mines are in the Pioneer mining district, two miles east of Rico, at an altitude of about 9800 ft. above sea level.

24 men are employed. Compensation insurance is carried.

The Argentine Group is opened by a shaft 167 ft. deep. From the bottom of the shaft two drifts have been driven , one south and the other east. The mine has been idle for a number of years and the work of unwatering it was completed only the day before my visit.

No work has as yet been done on the Rico Cons. since the company leased it, except that two men are employed putting up a pipe line to carry compressed air to the mine. As soon as this pipe line is finished, men will be put to work to extend some of the old drifts.

In the Bertha S. there are 5 men driving a crosscut, prospecting for the ore below the old workings. This crosscut is in about 500 ft. Machine drills are used.

A compressor house, blacksmith shop, hoist house, and transformer house have been erected recently. This surface plant is adequate ~~xxxxxxx~~ for the three properties at the present stage of development.

The Argentine shaft is well timbered with square sets and cribbing. It has two compartments, hoistway and ladder way. The ladder way has landings 20 ft. apart. The dimensions of the shaft are 4 ft. x 9 ft.

B. of Mines

9

STATE OF COLORADO
BUREAU OF MINES
INSPECTOR'S REPORT
TO
JOHN T. JOYCE,
COMMISSIONER OF MINES.

THE BLACK HAWK MINE
Name of Mine or Plant

Dolores County

August 28, 1926.

THE BLACK HAWK MINE is operated by the RICO-ARGENTINE MINING COMPANY, F. W. Price, President; J. H. Woodmansee, Secretary, 539 Atlas Block, Salt Lake City, Utah; A. P. Lofquist, Superintendent, Rico, Colo.

The mine is in the Pioneer mining district 1½ miles from Rico. The ore is sent over an aireal tramway 2000 ft. long to the wagon road, then hauled in wagons to Rico.

14 men are employed. Compensation insurance is carried.

There are two crosscuts, each about 350 ft. long. From these crosscuts levels have been opened. The levels are 160 ft. vertical distance apart, and are connected by upraise. The ore occurs in beds 10 ft. to 25 ft. thick, 20 ft. to 50 ft. wide and one bed has been worked 700 ft. in length. There are five known ore beds in the mine but two only have been worked to any extent.

No ore is shipped at present, but is stored in the mine and in stockpile on the surface until the mill under construction at Rico shall be ready to take ore for treatment. About 15 to 20 tons a day is mined at this time. The ore is a lead-zinc combine. Until recently regular shipments of 32% combine ore were made to the International Smelting Company's mill in Utah; with the new mill at Rico in operation ore lower in grade, perhaps as low as 20% combine can be mined and milled at a profit.

There is a blacksmith shop, an ore bin and tramway terminal at the portal of both levels.

The tramming is done by hand. One ton cars are used and the track is of 12 lb. rail.

The ground stands well. Stopes are timbered with square sets and partly filled with waste. Manways are kept in good repair.

Powder is stored in surface magazines.

[signature]

State Mine Inspector, District No. 4.

B. of Mines

Rico Mining Co.

County Dolores, Post Office, District

Name of Mine or Plant Argentine

REPORT TO BUREAU OF MINES

STATE OF COLORADO

FOR THE YEAR 1926

Name of Company or Title of Partnership: Rico Mining and Reduction Co.

Address of Principal Office: 812 International Life Bldg. St. Louis, Mo.

Names, titles and addresses of officers, partners or owners: Charles E. Schwarz - Manager; Duane M Kline - Supt.

If names of claims have been listed in previous reports, only changes, if any, need be given.

Names and numbers of patented claims: Stony Point 1498, Mt. Monarch 1454, Paris 1454, Zulu 1452, Black Chief 1649, Argentine 15233, Cashier 152.., D.B.+B. 3535, Honduras 7845, Eclipse 7289, + Humboldt 15833.

Total acreage 88.25

Names of unpatented claims

Total acreage

Do you own these claims, or do you operate them under lease? Lease + Bond

If you operate under lease, give name and address of company or person from whom leased: Mr. Henry Obendorfer - Trustee - Rico, Colo.

If you have given a lease to others for all or part of the property, state the names of the leasing companies, partnerships or individuals:

Name	Manager	P. O. Address

Is the work done by your lessees included in this report?

Have you a mill or reduction works: If so, what is its character and capacity?

Average contents of products sold. (If both crude ore and concentrates are sold, give average contents of each.)

Gold 4.01 oz.	Copper %	Iron 22 %	Tungstic acid %
Silver 3.5 oz.	Zinc 23 %	Sulphur %	Uranium oxide %
Lead 11 %	Manganese %	Insoluble %	Vanadium oxide %
Molybdenum %		Fluorspar %	

Crude ore sold tons Concentrates sold tons Milling ore produced tons

Gold or silver bullion produced, value

List of buildings, tramways, and other surface improvements made during the year: Shaft House, Hoist House, Compressor House, + Transformer House.

Amount and character of underground development during year: Shafts 125 ft

Winzes ft. Raises 50 ft. Drifts 420 ft. Crosscuts ft.

B. of Mines

Printing Co., Denver

290
291
295

IMPORTANT

BLANKS SHOULD BE COMPLETELY FILLED OUT AND RETURNED BY FEBRUARY 1, 1938

METAL MINES AND MILLS

Name of Mine or Plant St. Louis Tunnel and other properties
See remarks

County Dolores, Post Office Rico, District

REPORT TO BUREAU OF MINES

STATE OF COLORADO

FOR THE YEAR 1937

OPERATOR.

Name of Company, Partnership or Individual St. Louis Smelting & Refining Company

Address of Principal Office 722 Chestnut Street, St. Louis, Mo.

Local Office Rico, Colorado

If incorporated, under the laws of what state? Missouri

Names, titles and addresses of officers, partners.

Name and Address of Owner Same as operator

If names of claims have been listed in previous reports, only changes, if any, need be given.

Names and Numbers of patented claims

Total acreage

Names of unpatented claims

Total acreage

Do you own these claims, or do you operate them under lease? Own

Was your property operated in whole or in part during the past year? Only maintenance & development work

If you have given a lease to others for all or part of the property, state the names and P. O. address of the leasing companies, partnerships or individuals, together with the name or description of part leased, next below:

-

Is the work done by your lessees included in this report? -

Have you a mill or reduction works? No If so, what is its character and capacity?

List all improvements and developments made during the past year drifting from main tunnel and upraise from drift.

PRODUCTION None

CRUDE OR SHIPPING ORE: No. tons Average gross value per ton $

Total value $. Average grade of different metallic content in ores as follows:

Gold oz. Lead % Copper % Sulphur %
Silver oz. Zinc % Iron % Insoluble %

MILLING ORE: Tons milled . Milling processes employed

Average gross value per ton crude ore milled $. Average grade crude ore milled in different metals as follows:

Gold oz. Lead % Copper % Sulphur %
Silver oz. Zinc % Iron % Insoluble %

CONCENTRATES: No. tons concentrates obtained from ores milled . Ratio of reduction tons into 1. Average value per ton concentrates $. Total value $

Average grade concentrates in the different metals as follows:

Gold oz. Lead % Copper % Sulphur %
Silver oz. Zinc % Iron % Insoluble %

State average costs per ton for mining $, hauling $, freight $, milling $, smelting $

B. of Mines
BoM 1939a

April 15, 1939 State of Colo, B of Mines Inspector's Report
D.C. McNaughton

EXPLOSIVES are safely stored in well built magazines, complying with the law, at Blaine Tunnel and Black Hawk Tunnel.
CAPS are stored in a safe place.
CARBIDE is stored in a safe dry place.
Only one days supply of explosives is taken to the Argentine Tunnel and it is safely stored.

All these tunnels are equipped with Electric Blasting Machines, and both electric and hand fuse blasting is done.

ELECTRICITY is used at lower (Blaine) Tunnel ~~only~~ for power purposes. and surface lighting. It is well installed, insulated and guarded.
FIRE PROTECTION at Blaine Tunnel consists of water and chemical extinguishers. Tunnel is equipped with Fire Door.
At Black Hawk Tunnel, fire protection is chemical extinguishers. Buildings are located at a safe distance from mine operations. Tunnel is equipped with Fire Door.
No fire protection at Argentine Tunnel. Buildings are located legal distance from tunnel opening. Have Fire Door.

VENTILATION is natural and good, throughout.

MISCELLANEOUS: This property operated continuously throughout the year. Large bodies of ore have been uncovered in the various working places.

Late in 1938 construction of a 150 Ton Mill was started and was completed early in 1939. This Mill has not been operated to date. However they expect to start production about June 15th.

Construction of Tailings Disposal Pond necessitated the construction of 1500 ft. of flume and ditch to change the course of the creek, which is the main water supply of the town of Rico.

The Company owns a building in Rico, 40 ft. x 20 ft. which houses a large caterpillar tractor, and has living room in rear.

Everything is exceptionally clean and orderly about this property.

Respectfully submitted

D. C. McNaughton

State Mine Inspector, District No. 4

B. of Mines
1
BoM
19396

Eckhardt Printing Co., Denver

IMPORTANT March 18, 1939 ✓ OK Me

BLANKS SHOULD BE COMPLETELY FILLED OUT AND RETURNED BY [redacted]

318

METAL MINES AND MILLS

Name of Mine or Plant Rico Argentine

County Dolores, Post Office ...., District ....

REPORT TO BUREAU OF MINES

STATE OF COLORADO

FOR THE YEAR 1938

OPERATOR.

Name of Company, Partnership or Individual: Rico Argentine Mining Company

Address of Principal Office: 132 South Main Street, Salt Lake City, Utah

Local Office: Rico, Colorado

If incorporated, under the laws of what state? Utah

Names, titles and addresses of officers, partners:
J. C. Johnson, President 132 South Main, Salt Lake City, Ut.
P. C. Woolley, Vice Pres. " "
B. P. Hall, Treasurer 824 South Main, Salt Lake City, Ut.
J. G. Boley, Secretary 132 South Main, Salt Lake City, Ut.

Name and Address of Owner: Rico Argentine Mining Company

If names of claims have been listed in previous reports, only changes, if any, need be given.

Names and Numbers of patented claims: No change.

Total acreage

Names of unpatented claims: No change.

Total acreage

Do you own these claims, or do you operate them under lease? We own them.

Was your property operated in whole or in part during the past year? Entire year.

If you have given a lease to others for all or part of the property, state the names and P. O. address of the leasing companies, partnerships or individuals, together with the name or description of part leased, next below:

None

Is the work done by your lessees included in this report?

Have you a mill or reduction works? Yes. If so, what is its character and capacity? Flotation mill, 135 tons.

List all improvements and developments made during the past year
New mill cost $82,000.00 New mine equipment cost $18,000.00; Mine development cost $66,813.00.

PRODUCTION NONE.

CRUDE OR SHIPPING ORE: No. tons ..... Average gross value per ton $ .....

Total value $ ..... Average grade of different metallic content in ores as follows:

Gold oz.	Lead %	Copper %	Sulphur %
Silver oz.	Zinc %	Iron %	Insoluble %

MILLING ORE: Tons milled ..... Milling processes employed .....

Average gross value per ton crude ore milled $ ..... Average grade crude ore milled in different metals as follows:

Gold oz.	Lead %	Copper %	Sulphur %
Silver oz.	Zinc %	Iron %	Insoluble %

CONCENTRATES: No. tons concentrates obtained from ores milled ..... Ratio of reduction ..... tons into 1. Average value per ton concentrates $ ..... Total value $ .....

Average grade concentrates in the different metals as follows:

Gold oz.	Lead %	Copper %	Sulphur %
Silver oz.	Zinc %	Iron %	Insoluble %

State average costs per ton for mining $ ....., hauling $ ....., freight $ ....., milling $ ....., smelting $ .....

B. of. Mines.

RICO ARGENTINE MINING CO.
Rico, Colorado.

ORE PRODUCTION, 1939

LEAD - ZINC ORE:

Tons milled - 10,673. Milling Process employed - Selective Flotation
Average gross value per ton crude ore milled ______
Average grade of crude ore milled in different metals as follows:
Gold 0.012 oz. Lead 8.46%. Copper 1.06%. Sulphur 27.% (approx)
Silver 3.83 oz. Zinc 11.23%. Iron 20.% (approx) Insol. 15.% (approx)

COPPER ORE:

Tons milled - 1,011.6. Milling process employed - Flotation
Average gross value per ton crude ore milled
Average grade of crude ore milled in different metals as follows:
Gold 0.008 oz. (approx) Lead 1.0% (approx) Copper 5.16% Insol.--
Silver 4.06 oz. Zinc 1.25% " Iron ------- Sulphur-

CONCENTRATES

LEAD CONCENTRATES:

Tons milled 10,673.1. Tons lead concentrates 1,234.4. Ratio of concentration 8.59
Average net value per ton of concentrates $46.22 Total value $57,054
Average grade of concentrates in different metals as follows:
Gold 0.013 oz. Lead 58.95% Copper 0.75% Insol. 2.54%
Silver 19.25 oz. Zinc 7.82% Iron 7.72%

ZINC CONCENTRATES:

Tons milled 10,673.1. Tons zinc concentrates 1,652.1. Ratio of concentration 6.46
Average net value per ton of concentrates $24.10. Total value $39,809
Average grade of concentrates in different metals as follows:
Gold 0.008 oz. Lead 3.06% Copper 1.52%
Silver 4.719 oz. Zinc 52.80% Iron 6.94%

COPPER CONCENTRATES:

Tons milled 1,011.6. Tons copper concentrates 150.99. Ratio of concentration 6.70
Average net value per ton of concentrates $39.31. Total value $5,934.
Average grade of concentrates in different metals as follows:
Gold 0.030 oz. Lead 3.90% Copper 21.83% Insol. 8.00%
Silver 17.775 oz. Zinc 5.70% Iron 24.40%

B. of. Mines

unsure of date
1940

LIST OF NEW PROPERTIES PURCHASED

NAME OF CLAIM	SURVEY
Half Loaf	8017
Highland Chief	8017
Lowland Chief	8017
Little Zula	8017
Nancy Hanks	8017
Little George	8017
Little George Extension	8017
Hal Painter	8017
Shehoctan	8017
5/8 Sam Patch	8031
5/8 Hillside #1, #2, #3	7994
5/8 Home	8031
Shamrock	4832
Star Route	5970
Yanky Boy	6969
Smuggler	5912
Milan	1449
Confidence	1447
Florence	1452
Excelsior	1451 A
Marquita	1450
Atlantic Cable	1136
Gulch	1513
Riverside	590
Little Carrie	6392
G. L. P.	8017
Aztec M. S.	367
Florence M. S.	1452 B
Excelsior M. S.	1451 B
Eighty Eight	7348
5/8 Gem of Beauty	1164
Group Tract	
Graveyard Tract	
Thompson Tract	
Mineral rights under streets and alleys	
Mineral rights under town lots - Rico	
Mineral rights under Atlantic Cable	
Mineral rights under Gulch	
Mineral rights under Riverside	
Mineral rights under Beam Tract	
Mineral Rights under B.C.D. tracts	
Aetna	6796
Imp	6796
Saw Tooth	6796
Durango	1441
Apex	11583 A
Bald Eagle	10122
Caledonia	10122
Little Johnnie	10122
Eureka	6285
Enterprise	5916
Fraction	11814
Golden Age	5956
Hiawatha	6393
Kitchen	5917
Ontario	5923
Silver Age	5831
Song Bird	6392
Thompson	6394
Vestal	6252
Aspen	6512
Last Chance	6512
Brittle Silver	7458

NAME OF CLAIM	SURVEY
Contact	6895
Confidence	6896
Helen C.	7977
Lucy	1456
Millie	7988
Silver Glance	6201
Silver Glance #2	6201
Silver Glance #4	7976
S. M. G.	7986
Snow Flake	6216
Syndicate	2185
Star	6199
Selenide	7469
Stephenite	7980
W. L. Stephens	7017
New Discovery	1461 A
Bell	5911
Lone Tree	1230
Laura	5913
McIntyre	12302
Night Watch	5976
Redeemer	12304
Sun up	5910
Ute	6796
Snow Flake	5909
Group M. S.	11583 B
New Discovery M. S.	1461 B
3/4 Franklin	564
22/24 Golden Fleece	226
22/24 Isabella	2039
22/24 New Year	1538
Old Hickory	7979
Old Discovery	7975
Chestnut	435
Newman	436 A
Swansea	434
Telegraph	780
Black Cloud	8099
Pewter Dollar	8098
Weimar	6513
Matchless	6739
Newman M. S.	436 B
Aerial Tramway	
Improvements at Shamrock	
Improvements at Atlantic Cable	

B of Mines

STATE OF COLORADO

BUREAU OF MINES

INSPECTOR'S REPORT

District No. Four

Rico , Colorado

May 18, 1940 193

RICO - ARGENTINE MINE
Name of Mine, Quarry or Plant

Location 8 miles east of Rico, Colo. County of Dolores
(Nearest Post Office) Rico, Colorado(Pioneer Mining District)
reached by auto and trail

Owner
Rico Argentine Mining Company

Address Dooley Block, Salt Lake City, Utah

Operator
(Owner or Lessee) Rico Argentine Mining Company
J.G.Johnson, President
151 First Ave., Salt Lake City, Utah
W.G.Seeley, Secretary
132 Main Street, Salt Lake City, Utah
Address Edward Bean, General Superintendent, Rico,Colo.

Name of Agent, General Manager or other officer on whom to serve notices
C.T.Van Winkle, Gen Manager, Dooley Block, Salt Lake City, Utah.

Name and address of local manager or person in direct charge of operations at mine, quarry or plant
C.T.Van Winkle, Gen. Manager, Dooley Block, Salt Lake City, Utah

Character of ore or other products Sulphides, carrying gold, silver, lead, iron pyrites, copper and zinc.

Number employed underground 30 On surface 5 Mill 18 Miscellaneous 5

Remarks COMPENSATION INSURANCE is carried.
ACCIDENT REPORT BLANKS are on hand.
HAVE TELEPHONE.
FIRST AID SUPPLIES are provided.
HAVE CHANGE ROOMS.
SAFETY & SANITARY CONDITIONS, in general, are satisfactory.

DESCRIPTION OF MINE: This property is developed by five levels, at different distances apart.
During this year the company has carried on the following development and prospecting program:- They advanced the Blaine Tunnel, which is the main haulageway, in a southeasterly direction and cross-cut to

to the hanging wall of the Blackhawk fissure making a total of 705 ft. of drift and cuts. They have completed the 349 ft. 3-compartment raise which connects the Blaine Tunnel with the Argentine Level. On this Blaine Level they have done 708 ft. of diamond drill prospecting. They also sunk a 10 ft. winze, making a total of 1772 ft. of developing and prospecting on the Blaine Level

On the Humbolt Tunnel Level they drifted 32 ft. on the Humbolt fissure. This level is 40 ft. above the Blaine or main Tunnel.

In the Argentine Tunnel, which is midway between Blaine and Black Hawk Tunnels, they have extended the drift on the Allegheny fissure 81 ft. and the raise 49 ft, besides sinking a winze 8 ft., making a total of 138 ft. of development on the Argentine Level.

At the Black Hawk Tunnel or Log Cabin Level, they have raised 31 ft. and drifted 150 ft. on the Allegheny fissure.

The ore is found in beds or chimneys of various sizes and in fissure veins varying in width to 8 or more feet. The ore is a sulphide, carrying gold, silver, lead, copper, iron and zinc. Stated value is $18.00 per ton.

Lead-zinc ore is mined in the Blaine Tunnel in 100 Stope, 104 Stope, 102 Stope, 103 Raise, 100 Raise, No.2 Stope on No.1 Bed and No.2 Stope on No.2 Bed, in the Humbolt Tunnel on the Humbolt Fissure, on the Argentine Level in Argentine Bed No. 4, No.1 and No. 2 and on Black Hawk Level in Blackhawk Bed No. 6.

Copper ore is mined in the Blaine Tunnel only, in 100 Stope, 101 Stope, No.3 Stope of No.1 Bed and Copper Stope.

They are milling about 100 tons per day of lead and zinc ore. They ship about 420 wet tons of lead and zinc concentrates per month.

When milling copper ore they mill 104 tons per day. They ship about 22 dry tons of copper concentrates per month.

SURFACE PLANT: The modern Flotation Mill is of 150 tons capacity and is of concrete and steel construction covered with galvanized corrugated iron. Equipment consists of Ore Bins, Crusher, Grizzlies, Ball Mill, Classifier, Flotation Units, Conditioning Tanks, Thickening Tanks, Filters, Pumps, Conveyor Belts, etc. An inclined Conveyor Belt delivers the ore from the Crusher to 500 ton capacity Secondary Ore Bins, thence to the Ball Mill.

At the Blaine Tunnel they have enlarged the Dry and Change Room by a 40' x 13' one-story addition of wood construction covered with galvanized corrugated iron, equipped with 2 showers and individual lockers. The Blacksmith Shop has also been enlarged and improved. Other buildings at Blaine Tunnel include Assay Laboratory, a building housing Mill Office, Store Room and a fully equipped First Aid Room, and other small buildings used for various purposes, Tram Terminals, Ore Bins and Snow Sheds. The main Surface Explosives Storage Magazine is at Blaine Tunnel.

No SHAFT.

UNDERGROUND [illegible] is Battery Locomotive. All this equipment is in good condition.

TIMBERING: Considerable timbering is necessary in this mine and is well installed.

ALL OPENINGS are well covered and guarded.

LADDERS are well installed and in good condition.

EXPLOSIVES are safely stored in well built magazines, complying with the law, at Blaine Tunnel and Black Hawk Tunnel.
CAPS are stored in a safe place.
CARBIDE is safely stored in a dry place.
Only one day's supply of explosives is taken to the Argentine Tunnel and it is safely stored.
All these tunnels are equipped with Electric Blasting Machines, and both electric and hand fuse blasting is done.

ELECTRICITY is used at lower (Blaine) Tunnel for power purposes and surface lighting. It is well installed, insulated and guarded. All stations underground are electrically lighted and have telephones to the surface in all stations.

FIRE PROTECTION at Blaine Tunnel consists of water and chemical extinguishers. Tunnel is equipped with Fire Door.
At Black Hawk Tunnel fire protection is chemical extinguishers.
Buildings are located at a safe distance from mine operations. Tunnel is equipped with Fire Door.
Fire Protection at Argentine Tunnel is chemical. Buildings are located legal distance from tunnel opening. Have Fire Door.

VENTILATION is both natural and mechanical.

MISCELLANEOUS: This property operated continuously throughout the year.
Milling of lead and zinc ores and of copper ores is done on separate days which explains the different tonnages.
They started milling operations in September 1939, and have operated continuously to-date.
They have a very successful tailings disposal plant.
The company owns a building in Rico, 40' x 30' which houses a large caterpillar tractor, and has living room in rear.
Everything is exceptionally clean and orderly about this property.

Respectfully submitted,

D.C.McNaughton

State Metal Mine Inspector, Dist No. 4

B. of. Mines

Nov. 16, 1940 State of Colo., B. of Mines Inspector's Report
D.C. McNaughton

in driving the main heading and for raising and drifting at that point. Equipment consists of electrically driven reversible blower, and large flexible tubing.

FIRE PROTECTION is both water and chemical extinguishers. All surface buildings are spaced a safe distance apart and are built of wood covered with galvanized corrugated iron.

MISCELLANEOUS: The ore is found in beds and fissure veins of various widths and sizes, and consists of massive sulphides, carrying lead, zinc, copper and considerable silver. In various parts of the mine are immense beds of iron pyrites.

An unusual feature of this property is the warm springs located beyond the Mountain Springs Raise in the northwesterly drift. These springs rise from the side of the main tunnel, and particularly through a diamond drill hole. Warm water from this drill hole is used for drilling purposes.

Experienced miners are employed at all times, and every precaution is taken to safe-guard both men and property.

Everything is clean and orderly in and about the property.

Respectfully submitted

L. C. McNaughton

State Metal Mine Inspector, District No. 4

B. of Mines May 27, 1942 D.C. McNaughton

BoM 1942a

ALL OPENINGS are well covered and guarded.
LADDERS are well installed and in good condition.

EXPLOSIVES: are safely stored in well built magazines. Also underground distributing magazines for daily supply of powder are kept under lock and key.

Present powder regulations are fully observed. Licensed mine foremen dispense powder to the various working places. They also keep a record of who receives the powder and where it is used. They alone have the keys to the magazine.

CAPS are safely stored.

CARBIDE is stored in a safe dry place.

Both electric and hand fuse blasting is practiced.

ELECTRICITY is used at lower (Blaine) Tunnel for power purposes and surface lighting. It is well installed, insulated and guarded. All stations underground are electrically lighted and have telephone to the surface in all stations.

FIRE PROTECTION consists of high pressure water and chemical extinguishers and temporary fire doors.

VENTILATION is both natural and mechanical with electrically driven blowers.

MISCELLANEOUS: This property operated continuously throughout the year.

Since last report the Rico Argentine Mining Company has acquired over 250 acres from the Pellet interests at Rico. They have also acquired all the holdings of the International Lead Company of Rico.

Since last report, they installed a new saw mill, and they are now sawing considerable timber of their own to augment supplies available from other sources.

They are also installing a new electrically-driven pump at the Argentine Shaft.

They are experiencing considerable shortage of labor.

Priorities seem to be satisfactory.

They have a very successful tailings disposal plant.

The company owns a building in Rico, 40' x 30' which houses a large caterpillar tractor, and has living room in rear.

Everything is exceptionally clean and orderly about this property.

The Company cooperates fully with the Bureau of Mines and insists upon observance of safety rules and regulations.

Respectfully submitted,
D. C. McNaughton
State Metal Mine Inspector, District No. 4

B of Mines Mining Record 1-25-41

RICO ARGENTINE HAS MADE REPORT FOR HALF OF 1941

Rico, Colo.—For the first six months of 1941 the Rico Argentine Mining Co. reports profit of $19,818 after deductions for depreciation and depletion but before federal and state income taxes. This compares with $25,233 for the like period of 1940 and $30,167 for the previous six months.

Gross income, including $102,060 in land sales and $101,543 zinc sales, totaled $205,574 against $179,289 for the first half of 1940.

Company offices are at 132 S. Main St., Salt Lake City, Utah, and James R. Hagie of Los Angeles is president.

RICO ARGENTINE MAKES REPORT ON 1942 OPERATION

3-25

Rico, Colo. — C. T. Van Winkle of Salt Lake City, president and general manager of the Rico Argentine Mining Co. operating here, shows in his annual report for 1942 a net profit to surplus off $60,602 before provision for depletion, compared with $60,074 in 1941. Total returns amounted to $471,291 and total expense including $72,028 for new equipment and construction came to $410,688.

Metals produced from 3355 tons of lead concentrates and 6045 tons of zinc concentrates were as follows:

Gold in lead concentrate, 67.58 oz.; gold in zinc concentrate, 70.10; total gold, 137.68 oz.

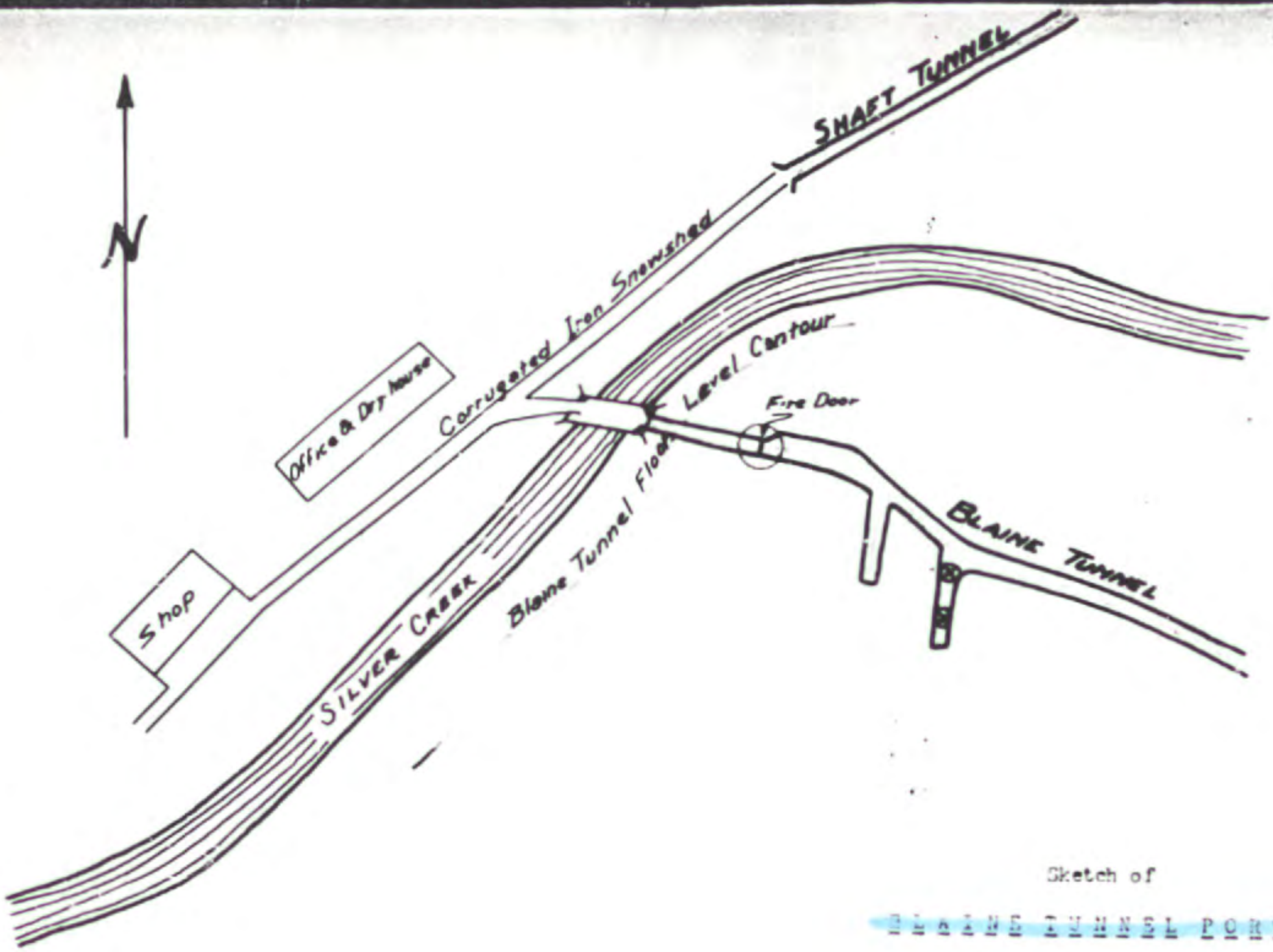
Silver in lead concentrate, 86,807 oz.; silver in zinc concentrate, 32,902 oz; total silver, 119,709 oz.

Lead in lead concentrate, 4,549,543 lbs.; lead in zinc concentrate, 435,970 lbs.; total lead, 4,985,543 lbs.

Zinc in lead concentrate, 349,430 lbs.; zinc in zinc concentrate, 5,915,153 lbs.; total zinc, 6,264,583 lbs.

In addition, 2178 tons of pyritic ore were mined and sold to vanadium producers. The grade of ore was improving during 1942 and the management expects favorable results during 1943. Current quick assets total $93,482 and current liabilities $47,438. Total development for the year included 3309 feet of drifting, crosscutting, raising, winzes and shaft sinking, as well as 900 feet of diamond core drilling.

B of Mines



Sketch of

B L A I N E T U N N E L P O R T A L

Rico Argentine Line

Scale 1" - 50'   April, 1942

H. T. Venable

B. of Mines

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IMPORTANT

BLANKS SHOULD BE COMPLETELY FILLED OUT AND RETURNED BY MARCH 1, 1944

B

METAL MINES AND MILLS

Name of Mine or Plant Black Hawk

County Dolores, Post Office Rico, District Pioneer

REPORT TO BUREAU OF MINES

STATE OF COLORADO

For the Year 1943

OWNER
Name of Company, Partnership or Individual: Rico Argentine Mining Company

Address of Principal Office 132 South Main Street, Salt Lake City, Utah

Local Office Rico, Colo.

If incorporated, under the laws of what state? Utah

Names, titles and addresses of Officers, Partners, Individuals: See No. 204

If names of claims have been listed in previous reports, only changes, if any, need be given:
Names and numbers of patented claims
See former Lists
Total acreage
Names of unpatented claims
Total acreage

Do you operate these claims yourself or are they being worked under lease? Operated under lease agreement

Was property operated in whole or in part during the past year?

If you have given a lease for all or part of the property give names and P. O. address of said lessees, together with description of part leased. Vanadium Corporation of America, Monticello Utah operated a portion for production of Iron Pyrites, for use in their Vanadium Plant

Is the work done by your lessees included in this report? No operation other than noted above

Have you a mill or reduction works? If so, what is its character and capacity?

List all improvements and developments made during the year

OPERATOR
Name of Company, Partnership or Individual: Vanadium Corporation of America
Monticello, Utah

Address of Office

Name and address of those in charge of work

PRODUCTION

CRUDE OR SHIPPING ORE: No. of tons 1259.568 Average gross value per ton $ 2.20 (to us)

Total value $ Average grade of different metallic content in ores as follows:

Gold oz.	Lead %	Copper %	Sulphur 45 %
Silver oz.	Zinc %	Iron 45 %	Fluorspar %
Tungsten %	Vanadium %	Uranium %	Molybdenum %

MILLING ORE: Tons milled Milling processes employed

Average gross value per ton crude ore milled $ Average grade crude ore milled in different metals as follows:

Gold oz.	Lead %	Copper %	Sulphur %
Silver oz.	Zinc %	Iron %	Fluorspar %
Tungsten %	Vanadium %	Uranium %	Molybdenum %

BULLION: Sold to U. S. Mint or other places Total amount: Gold oz.

Silver oz.

B. of Mines

STATE OF COLORADO
BUREAU OF MINES

INSPECTOR'S REPORT

District No. Four

Rico Colorado May 22 1946

RICO ARGENTINE MINES & MILL
(Name of Mine, Quarry or Plant)

County Dolores
Pioneer Mining District
Location 2 miles east of Rico, Colorado Rico, Colorado
(Nearest Town)
Reached by auto and trail
Owner Rico-Argentine Mining Company

Address Dooley Block, Salt Lake City, Utah

Operator Rico-Argentine Mining Company Owner ~~or Lessee~~
C.T. Van Winkle, Pres & Gen.Mgr., Salt Lake City, Utah and Rico, Colo
Address J.C. Johnson, Vice-Pres., 151 First Ave., Salt Lake City, Utah
W.G. Seeley, Secretary, 132 Main St., Salt Lake City, Utah

Name and address of agent, general manager or other officer on whom to serve notices
C. T. Van Winkle, Gen. Mgr., Dooley Block, Salt Lake City, Utah and Rico, Colo

Name and address of local manager or person in direct charge of operations
C.T. Van Winkle, Gen. Mgr., Dooley Block, Salt Lake City; Utah and Rico, Colo

Name and address of company or person to whom notification of Annual Report should be sent
C.T. Van Winkle, Gen. Mgr., Dooley Block, Salt Lake City, Utah and Rico, Colo

Character of ore or other products Sulphides, carrying gold, silver, Copper, lead, iron pyrites and zinc.
Production from Rico Argentine Mine was 19,876 tons ore.
They milled from the entire group of mines, 38,882 tons

Producing ~~Not Producing~~

Number employed underground 31 ~~On surface~~ Mill 14
Mine Surface .... 9 Miscellaneous 4 Mill Surface 7

Compensation insurance carried ~~Compensation not carried~~
Accident Report Blanks are on hand.
Remarks Have Telephone.
First Aid Supplies are provided.
Have Change Rooms.
Safety and Sanitary Conditions, in general, are satisfactory.

DESCRIPTION OF MINE:- This property is developed by five levels, at different distances apart. The Blaine Tunnel is the main haulageway.
The Company is carrying on a major program of development at all

times.

Operations on the Rico-Argentine (proper) during the past year:-

Stoping continued on the 200 ft. Level.

A cross-cut was driven from the South Drift on the 300 ft. Level. 600 ft. to intersect the downward extension of ore bodies on the 200 ft.Level

Operations on the Blaine Tunnel Level during the past year:-

The Rico Consolidated fissure was prospected by drifting, and the downward extension of ore bodies on upper levels were intersected by cross-cutting and raising.

A drift has been started to prospect the Last Chance fissure.

Diamond drilling was done to prospect the Rico Argentine and Black Hawk fissures.

Diamond drilling on various levels of the Rico Argentine was 1596 feet.

The Raise connecting the Argentine No. 3 Level with No.2 Level,started in 1945, has been completed. This raise is for ventilation purposes.

Electric and Air-driven Slusher Units are used in all stopes.

Both electric and air-driven Tugger-type Hoists are used in all raises inclines,etc. Hoists are equipped with ¼" to ½" steel cable. Hoists,cables and skips are all in good condition.

Production from the Rico Argentine Mine was 19,876 tons.

The Rico Argentine Mill milled 35,882 tons from all the mines of the Rico Argentine Group.

The mine is closed Sundays, but the mill operates continuously.

The ore is found in beds and chimneys of various sizes and in fissure veins varying in width to 5 or more feet. The ore is a sulphide, carrying gold, silver, copper, lead, iron and zinc. Stated value of ore is up to $20.00 a ton.

Wet drilling is practiced exclusively.

Mucking machines are used in all headings.

SURFACE PLANT:- The modern Flotation Mill has a capacity of 150 tons. It is constructed of steel and concrete, and covered with galvanized, corrugated iron. Equipment consists of Ore Bins, Crusher, Grizzlies, Ball Mill, Classifier, Flotation Units, Conditioning Tanks, Thickening Tanks, Filters, Pumps, Conveyor Belts,etc. An Inclined Conveyor Belt delivers the ore from the Primary Crushers to 500-ton capacity Secondary Ore Bins, thence to the Ball Mill. All moving parts are well guarded.

At the Blaine Tunnel is a Dry and Change Room with Showers and individual lockers, also Mine Office Building. Other buildings include a large Blacksmith Shop, which processes steel for the entire group of mines; Compressor House, which houses three electrically-driven Air Compressors; Machine Shop; Electric Shops; Assay Office and well equipped Laboratory; a building housing Mine Office; Store Room and a fully equipped First Aid Room and other small buildings used for various purposes, all of wood, steel and concrete construction, covered with galvanized corrugated iron, also Tram Terminals, Ore Bins and Snow Sheds.

New additions have been added to various buildings from time to time.

A well-equipped Saw Mill is located in the yards.

Men live in Rico.

In the town of Rico is located the Engineering Office, Administration Offices, etc.

SHAFTS:- The old Argentine Shaft mentioned in previous reports is used now only for ventilation and exit for men. Also all water from lower levels is pumped thru this shaft to the surface. It is maintained in good condition.

All ores are now hoisted to Blaine (No.1) Tunnel thru No.3 Shaft which is 3-compartment, 280 feet in depth and connects No.3 Argentine Level with Blaine (No.1) Level. No.3 Shaft is equipped with single-drum electrically-driven Hoist with 3/4" Cable and Cage. All this equipment, fastenings, etc., is kept in good condition. All moving parts are covered and guarded.

UNDERGROUND HAULAGE is Battery Locomotive on main haulageway, man power on all other levels. All this equipment is in good condition.

TIMBERING:- Considerable timbering is necessary in this mine, and is well installed. All openings are well covered and guarded. Ladders are well installed and in good condition.

EXPLOSIVES:- Explosives are safely stored in well-built Magazines. Underground Distributing Magazines for daily supply of powder are kept in good condition. Caps are safely stored. Carbide is stored in a safe, dry place. Both electric and hand blasting is practiced.

ELECTRICITY is used for power and lighting both underground and surface. It is well installed, insulated, grounded and guarded.
They have telephone to the surface in all stations.

FIRE PROTECTION consists of high pressure water and chemical extinguishers Fire Doors are provided.

VENTILATION is both natural and mechanical, with electrically-driven Blowers.

MISCELLANEOUS:- This property operated continuously throughout the year. They are now milling approximately 110 tons per 24 hour day in the Rico-Argentine Mill, making two products, one silver-lead, the other zinc.
Concentrates are trucked two miles to the R.G.S.Railroad, thence shipped by rail to smelters.
The Saw Mill mentioned in this report goes a long way toward alleviating the difficulty of obtaining commercial lumber.
The Rico Argentine Company maintains a Caterpillar Tractor, equipped with both Snow Plow and Dozer which they use for building and maintaining roads to all of their operating units.
Everything is exceptionally clean and orderly about this property
The Company co-operates fully with the State Bureau of Mines and with the Inspector, and insists upon observation of safety rules and regulations.

Respectfully submitted

O.C. McNaughton

State Metal Mine Inspector, District No. 4

B. of Mines

U. S. B. OF MINES
JUL 2 1971

1845 Sherman Street
Denver, Colorado 80203

STATE OF COLORADO

FILED FOR RECORD

Date JUL 2 1971

Assistant Commissioner of Mines

BUREAU OF MINES
Department of Natural Resources

INFORMATION REPORT
No. I-43

Date June 10, 1971
County Dolores

RICO ARGENTINE MINE	Mine
Name of Operation	Kind of Operation
Rico Argentine Mining Company	Box 158, Rico, Colorado 81322
Operator	Address of Operator
Rico Argentine Mining Company	Box 158, Rico, Colorado 81322
Owner	Address of Owner
Orval Jahnke	Box 158, Rico, Colorado 81322
Person Locally in Charge	Address of Person in Charge
Rico Argentine Mining Company	Continuous from 1970 This mine ceased operation May 26, 1971.
To Whom Shall Annual Report Be Sent	If New Operation, When Did Work Start

Producing ____ Development ____ Exploration ____ Part Time ____ Idle ____

Products Lead, zinc, copper, gold, & silver. Monthly Rate of Production ____

Value of Products $ ____ Number of Days Operated 90 days 19 71

Men Employed: Total 5 Underground 4 Surface 1 Other ____

Location This mine is located one mile east of Rico, Colorado on Silver Creek: Sec 20 T40N R10W

Description of Property & Operation Mining operations were ceased May 26, 1971. All equipment has been removed below the 500, 600, and 700 levels, including the shaft sinking hoist. These lower levels will be allowed to flood, the St. Louis Tunnel is connected at the 500 level and any flooding above this elevation will be drained through this connection.

A merger has been anticipated and any resumption of mining operations depends on the outcome of this. The Rico Argentine Company has no plans for reopening and development at this time.

Surface Buildings Same

Machinery, Compressors, Hoists, Etc. All machinery has been removed from underground on 500, 600, and 700 levels.

Type of Ground Support Post - Pillars and Square Sets

Ventilation Mechanical

Geological Formation Rico Formation

Size of Vein or Deposit Veins and beddings.

Miscellaneous (Obtain a Current Underground Map)

Rico Argentine Mining Co. Colorado

George M. [illegible]
Inspector

4
District No.

BM 2 (Rev. 3-70)

B of Mines

1845 Sherman Street
Denver, Colorado 80203

U. S. B. OF MINES
JUN 1971

FILED FOR RECORD

Date JUN 1 1 1971

Assistant Commissioner of Mines

STATE OF COLORADO

BUREAU OF MINES
Department of Natural Resources

INFORMATION REPORT

No. I-32

COLORADO ... JUN 1971

Date May 26, 1971

County Dolores

RICO ARGENTINE MILL	Mill
Name of Operation	Kind of Operation
Rico Argentine Mining Company	Box 157, Rico, Colorado 81323
Operator	Address of Operator
Rico Argentine Mining Company	Box 157, Rico, Colorado 81323
Owner	Address of Owner
Orval Jahnke	Box 157, Rico, Colorado 81323
Person Locally in Charge	Address of Person in Charge
Rico Argentine Mining Company	Continued from 1970
To Whom Shall Annual Report Be Sent	If New Operation, When Did Work Start

Producing X Development Exploration Part Time Idle

Products Lead, zinc, gold, copper, and silver Monthly Rate of Production 1,500 tons

Value of Products $ Market Prices Number of Days Operated 130 days 1971

Men Employed: Total 6 Underground Surface 6 Other

Location This mill is located one mile east of Rico, Colorado on Silver Creek: Sec 20 T40N R10W

Description of Property & Operation The mill was closed down May 26, 1971. There will be some cleanup work with no knowledge of when it may start up again. The last month was spent running the tailings pond and dump material. All known ore reserves in the mine have been depleted and no exploration program has been planned at the present time.

A merger with another mining company has been underway for some time but at the present time propects are very doubtful if this will be completed. All future plans depend on these negotiations.

Surface Buildings Same

Machinery, Compressors, Hoists, Etc. Same

Type of Ground Support Does not apply

Ventilation Does not apply

Geological Formation Does not apply

Size of Vein or Deposit Does not apply

Miscellaneous (Obtain a Current Underground Map)

Rico Argentine Mining Co

Inspector

District No. 4

BM 2 (Rev. 3-70)

B. of Mines

STATE OF COLORADO
BUREAU OF MINES
DEPARTMENT OF NATURAL RESOURCES
1845 Sherman Street
Denver, Colorado 80203

NORMAN R. BLAKE
DEPUTY COMMISSIONER

COLORADO BUREAU ...
JAN 17 1972

OK

FILED FOR RECORD

Date APR 7 1972

Assistant Commissioner of Mines

Number 75
County Dolores
Mining District Pioneer

OPERATOR'S ANNUAL REPORT

for the Year 1971

Name of Operation RICO MILL Kind of Operation Mill (Mine, Mill, Quarry, etc.)

Operator Rico Argentine Mining Company Ownership (X) Lease ( ) Contractor ( )

Address (Local) Box 158, Rico 81322 Main Office Address 605 Kearns Bldg., Salt Lake City, Utah

Owner Owner Address

Location of Property Rico, Colorado

Corporation (X) Partnership ( ) Individual ( )
If a corporation, give name of state in which incorporated Utah

President Sherman B. Hinckley Partner or Individual

Vice-President J.E. Hogle, Jr. Partner

Secretary L.J. Lerwill Partner

Treasurer L.J. Lerwill Partner

Manager or Person in Charge O.L. Jahnke, Supt. Address Rico, Colorado Telephone Number 967-2281

Producing ( ) Developing ( ) Prospecting ( ) Part Time ( ) Idle (X)

Principal Products Lead & Zinc Ore Concentrates

IMPORTANT

Stabilization and Reclamation

Mined ______ Acres Mined During Year ______ Acres Reclaimed During Year ______
Dump or Stockpile Area ______ (acres) Dump or Stockpile Area Reclaimed ______ (acres)

Production for the Year

Crude Tonnage (tons, yards, pounds) Produced during the Year 967 Tons Value $ 146,830.87

List products separately, i.e., Gold, Silver, Copper, Lead, Zinc, or other minerals, Clay, Sand, Gravel, Stone, etc.

Product		(oz., lbs., tons)		Value $
Product	Lead	438,713	lbs.	44,255.92
Product	Zinc	657,703	lbs.	79,213.95
Product	Gold	13.275	ozs.	104.49
Product	Silver	13,377.78	ozs.	19,940.08
Product	Cadmium	3,230.92	ozs.	3,316.43

Labor Statistics

Number of Days Operated during the Year 100 Average No. of Men Employed: Undergd. ______ Surface 9

Number of Man-shifts (8 hours each) during the Year: Underground ______ Surface 902.5

Number of Lost-time accidents during the Year ______ Man-hours worked 7220.0

Compensation Insurance Carrier Colo. State Comp.

Date of this report 1-10-72 Signed Rico Argentine Mining Co.

By: [signature]

Title Controller

This report must be submitted to the Colorado Bureau of Mines by March 1, 19 72

BM 8 (Rev. 10-71)

(over)

B. of Mines

STATE OF COLORADO
BUREAU OF MINES
DEPARTMENT OF NATURAL RESOURCES
1845 Sherman Street
Denver, Colorado 80203

NORMAN R. BLAKE
DEPUTY COMMISSIONER

COLORADO BUREAU OF MINES
1972

FILED FOR RECORD

Date APR 7 1972

Assistant Commissioner of Mines

Number 73
County Dolores
Mining District Pioneer

OPERATOR'S ANNUAL REPORT
for the Year 1971

Name of Operation ARGENTINE MINE — Kind of Operation Mine (Mine, Mill, Quarry, etc.)

Operator Rico Argentine Mining Company — Ownership (X) Lease ( ) Contractor ( )

Address (Local) Box 158, Rico 81322 — Main Office Address 604 Kearns Bldg., Salt Lake City, Utah

Owner ______ Owner Address ______

Location of Property Rico, Colorado

Corporation (X) Partnership ( ) Individual ( )
If a corporation, give name of state in which incorporated Utah

President Sherman B. Hinckley — Partner or Individual ______

Vice-President J.E. Hogle, Jr. — Partner ______

Secretary L.J. Lerwill — Partner ______

Treasurer L.J. Lerwill — Partner ______

Manager or Person in Charge O.L. Jahnke, Supt. — Address Rico, Colorado
Telephone Number 967-2281

Producing ( ) Developing ( ) Prospecting ( ) Part Time ( ) Idle (XX)

Principal Products Lead - Zinc

IMPORTANT

Stabilization and Reclamation

Acres Mined * — Acres Mined During Year None — Acres Reclaimed During Year None
Dump or Stockpile Area ______ (acres) — Dump or Stockpile Area Reclaimed None (acres)

*Mining consisted of cleaning up old workings

Production for the Year

Crude Tonnage (tons, yards, pounds) Produced during the Year 967 Tons — Value $ 146,830.87

List products separately, i.e., Gold, Silver, Copper, Lead, Zinc, or other minerals, Clay, Sand, Gravel, Stone, etc.

Product	(oz., lbs., tons)	Value $
Lead	438,713 lbs.	44,255.92
Zinc	657,703 lbs.	79,213.95
Gold	13.275 ozs.	104.49
Silver	13,377.78 ozs.	19,940.08
Cadmium	3,230.92 lbs.	3,316.43

Labor Statistics

Number of Days Operated during the Year 107 — Average No. of Men Employed: Undergd. 7 Surface ______

Number of Man-shifts (8 hours each) during the Year: Underground 732 Surface ______

Number of Lost-time accidents during the Year ______ Man-hours worked 5856

Compensation Insurance Carrier Colo. State Comp.

Date of this report 1-10-72 — Signed Rico Argentine Mining Co.

By: D. Haack

Title Controller

This report must be submitted to the Colorado Bureau of Mines by March 1, 1972.

BM 8 (Rev. 10-71)

(over)

B. of Mines

STATE OF COLORADO
BUREAU OF MINES
DEPARTMENT OF NATURAL RESOURCES
1845 Sherman Street
Denver, Colorado 80203

NORMAN R. BLAKE
DEPUTY COMMISSIONER

#3
04

JAN 17 1972

FILED FOR RECORD

Date APR 7 1972

Assistant Commissioner of Mines

Number 172
County Dolores
Mining District Pioneer

OPERATOR'S ANNUAL REPORT
for the Year 1971

Name of Operation ST LOUIS TUNNEL
Kind of Operation Mine (Mine, Mill, Quarry, etc.)

Operator Rico Argentine Mining Company
Ownership (XX) Lease ( ) Contractor ( )

Address (Local) Box 158, Rico 81332
Main Office Address 605 Kearns Bldg., Salt Lake City, Utah

Owner
Owner Address

Location of Property Rico, Colorado

Corporation (XX) Partnership ( ) Individual ( )
If a corporation, give name of state in which incorporated Utah

President Sherman B. Hinckley
Partner or Individual

Vice-President J.E. Hogle, Jr.
Partner

Secretary L.J. Lerwill
Partner

Treasurer L.J. Lerwill
Partner

Manager or Person in Charge Orval L. Jahnke, Supt.
Address Rico, Colorado
Telephone Number 967-2281

IMPORTANT

Producing ( ) Developing ( ) Prospecting ( ) Part Time ( ) Idle (X)

Principal Products Lead & Zinc Ore

Stabilization and Reclamation

Total Acres Mined No Surface Mining - Acres Mined During Year None Acres Reclaimed During Year None
Dump or Stockpile Area None (acres) Dump or Stockpile Area Reclaimed None (acres)

Production for the Year

Crude Tonnage (tons, yards, pounds) Produced during the Year None Value $ -0-

List products separately, i.e., Gold, Silver, Copper, Lead, Zinc, or other minerals, Clay, Sand, Gravel, Stone, etc.

Product None	(oz., lbs., tons)	Value $
Product	(oz., lbs., tons)	Value $
Product	(oz., lbs., tons)	Value $
Product	(oz., lbs., tons)	Value $
Product	(oz., lbs., tons)	Value $

Labor Statistics

Number of Days Operated during the Year ______ Average No. of Men Employed: Undergd. ______ Surface ______

Number of Man-shifts (8 hours each) during the Year: Underground ______ Surface ______

Number of Lost-time accidents during the Year ______ Man-hours worked ______

Compensation Insurance Carrier Colorado State Comp.

Date of this report 1-10-72

Signed Rico Argentine Mining Co.

By: [signature]

Title Controller

This report must be submitted to the Colorado Bureau of Mines by March 1, 1972.

BM 8 (Rev. 10-71)

(over)

B. of Mines

1845 Sherman Street
Denver, Colorado 80203

FILED FOR RECORD

DEC 3 1 1973

Assistant Commissioner of Mines

STATE OF COLORADO

BUREAU OF MINES
Department of Natural Resources
INFORMATION REPORT

No. I-165

Date November 28, 1973

County Dolores

RICO ARGENTINE MINING COMPANY	Mine Dumps, Claims and Office
Name of Operation	Kind of Operation
Rico Argentine Mining Company	Box 158, Rico, Colorado 81332
Operator	Address of Operator
Rico Argentine Mining Company	Box 185, Rico, Colorado 81332
Owner	Address of Owner
Orval Jahnke	Box 158, Rico, Colorado 81332
Person Locally in Charge	Address of Person in Charge
Rico Argentine Mining Company	Continued from 1972
To Whom Shall Annual Report Be Sent	If New Operation, When Did Work Start

Producing none Development none Exploration X Part Time No Idle

Products None Monthly Rate of Production None

Value of Products $ Number of Days Operated 240 days 1973

Men Employed: Total 5 Underground None Surface 5 Other None

Location

Total Acres Mined Acres Mined During Year Acres Reclaimed During Year

Dump or Stockpile Area Acres Dump or Stockpile Area Reclaimed Acres

Description of Property & Operation: The Rico Argentine Mining Company was engaged in sampling mine dumps for silver and other minerals; they were also engaged in building a pilot plant for extracting silver from mine dumps. Plans are being made to build a larger plant at the old acid plant site. The new plant will be a type of leaching. Assessment work was done on all mining claims, and buildings were repaired.

Surface Buildings: Same as the 1973 report.

Machinery, Compressors, Hoists, Etc.: Some mining machinery is being liquidated.

Type of Ground Support: Does not apply.

Ventilation: Does not apply.

Geological Formation: Does not apply.

Size of Vein or Deposit: Does not apply.

Miscellaneous (Obtain a Current Underground Map)

Inspector Harry M. Tracy / Ray T. Hight District No. 4

BM 2 (Rev. 9 72)

· B. of Mines

BoM 1974

1845 Sherman Street
Denver, Colorado 80203

STATE OF COLORADO

B

FILED FOR RECORD

Date ... 1 8 1974

Assistant Commissioner of Mines

BUREAU OF MINES
Department of Natural Resources
INFORMATION REPORT
No. I-128

Date December 5, 1974
County Dolores

RICO ARGENTINE	Mill (Crushing & Leaching)
Name of Operation	Kind of Operation
Rico Argentine Corporation	Box 158, Rico, Colorado 81332
Operator Phone 967-2281	Address of Operator
Rico Argentine Corporation	Box 158, Rico, Colorado 81332
Owner	Address of Owner
Orval Jahnke	Box 158, Rico, Colorado 81332
Person Locally in Charge	Address of Person in Charge
Rico Argentine Corporation	Continuous from 1973
To Whom Shall Annual Report Be Sent	If New Operation, When Did Work Start

Producing X Development Exploration Part Time Idle
Products Gold and Silver Monthly Rate of Production No. exact figure at this time.
Value of Products $ Approximately $12 per ton Number of Days Operated 260 days 19 74
Men Employed: Total 16 Underground Surface 16 Other

Location The Rico Argentine Mill is located one mile north of Rico, Colorado. (Old acid plant location is Sec 25 T-39N R-10W N.M.P.M.)

(Several old mine dumps are being cleaned up and hauled to the leaching pads.)

Total Acres Mined Acres Mined During Year Acres Reclaimed During Year
Dump or Stockpile Area Acres Dump or Stockpile Area Reclaimed Acres
(No figures areavailable until the dumpcleanups are completed.)

Description of Property & Operation / Surface Buildings: A precipatation and recovery plant has been built in the old shopand storage buildings. The smelter has been constructed adjacent to the same building; the product from the leaching and presses is processed and then smeltered into gold and silver bullion at this location. Original crushing plant for acid plant operation was used. A saucer shaped leaching pad has been formed from one of the old tailings ponds located at the old acid plant settling ponds; size of the pad is aporoximately 300 ft. by 500 ft. The leaching basin is lined with a complete Hyplon covering extending up on berm sides of the basin approximately 4 ft. Thepad was designed on a slope completely around the leach pile, all leach liquors follow this natural flow to a stilling basin, pumped from the basin into mill processing and returned to leach circuit, forming a closed liquor leach circuit.

CONTINUED ON PAGE 2

Machinery, Compressors, Hoists, Etc.
1 - Joy Front Loader
1 - Caterpillar w/Dozer & Ripper
Several Trucks
Pumps, leach tanks presses, smelter and other misc. processing equipment.

Type of Ground Support: Does not apply

Ventilation: Does not apply

Geological Formation: Does not apply

Size of Vein or Deposit: Does not apply

Miscellaneous (Obtain a Current Underground Map)

Thomas R. [illegible] — Inspector

4 — District No.

BM 2 (Rev. 9 72)

Rico Argentine Mill - Dolores County

Cyanide solution of approximately three pounds per ton of H_2O is used as primary leach reagent. Small amounts of lime and zinc are used in the circuit for collection of the gold and silver in the leach ore pile. The ore leach pile contains approximately 100,000 tons of raw ore; this ore was hauled from the old mine dumps from several of the gold mines in this area.

First part of the ore was crushed to an average size of 1 1/2 inch, the finish of the leaching pile was made by using the ore from dumps in its original mined sizes. The leaching solution is pumed through a series of lines and distributed over the top of the leach pile by using rainbird sprinkler hoses. Soaker hoses were tried unsuccessfully, the solution did not contain proper amount of oxygen without sprinkling for oxidation. A buildup of liquor in the leach pile caused a spill over the outer berm early in the startup, solution ran into the Dolores River and caused considerable amount of undue concern. To prevent any further accidents of this nature the pad berm was raised to 4 1/2 ft. to 6 ft. A secondary retaining berm has been built between the leaching pad and the Dolores River up to 6 ft. to 10 ft. The Dolores River has been returned to the original channel, creating considerable more distance from the leach pad to the stream.

The water is checked twice daily for any pollution above and below the leaching pad to prevent any pollution of the natural stream.

After the leaching process has been completed in this pad plans are to use leached ore to refill and resurface the old settling ponds formerly used at the acid plant location. Plans are to construct other leach pads in these ponds as operation continues.

Thomas D. High

Thomas D. High
District Metal Mining Inspector

rb

B. of Mines

BoM 1975a

STATE OF COLORADO
DIVISION OF MINES
DEPARTMENT OF NATURAL RESOURCES
1845 Sherman Street
Denver, Colorado 80203

METAL & NONMETAL MINE OPERATOR'S ANNUAL REPORT
for the Year 1974

NORMAN R. BLAKE
DEPUTY COMMISSIONER
FILED FOR RECORD

Date MAY 3 1 1975

Assistant Commissioner of Mines

RECEIVED
MAR 6 1975
COLO. DIVISION OF MINES

Number 71
County Dolores
Mining District

Name of Operation RICO ~~Mill~~ Argentine Leaching Plant Kind of Operation Milling (Mine, Mill, Quarry, etc.)

Operator Rico Argentine Mining Corporation Ownership (X) Lease ( ) Contractor ( )

Address (Local) Box 158, Rico 81332 Main Office Address Same

Owner Rico Argentine Mining Company Owner Address Same

Location of Property 1 mile North of Rico, Colorado

Corporation (X) Partnership ( ) Individual ( )
If a corporation, give name of state in which incorporated Texas

President R. M. Roberts Partner or Individual

Vice-President O. L. Jahnke Partner

Secretary L. G. Caskey Partner

Treasurer Bruce Crider Partner

Manager or Person in Charge O. L. Jahnke Address P. O. Box 156, Rico, Colorado 81332
Telephone Number 967-2281--967-2451--967-2301

Producing (X) Developing ( ) Prospecting ( ) Part Time ( ) Idle ( )

Principal Products Silver--Gold

STABILIZATION AND RECLAMATION

Total Acres Mined Acres Mined During Year Acres Reclaimed During Year
Dump or Stockpile Area 2.5 (acres) Dump or Stockpile Area Reclaimed 2.5 (acres)

PRODUCTION FOR THE YEAR

Crude Tonnage (tons, yards, pounds) Produced during the Year 81,000 Value $ 1,200,000

List products separately, i.e., Gold, Silver, Copper, Lead, Zinc, or other minerals, Clay, Sand, Gravel, Stone, etc.

Product Gold	(oz., ~~lbs., tons~~)	200	Value $ 35,000
Product Silver	(oz., ~~lbs., tons~~)	25,900	Value $ 103,000
Product	(oz., lbs., tons)		Value $
Product	(oz., lbs., tons)		Value $
Product	(oz., lbs., tons)		Value $

LABOR STATISTICS

Number of Days Operated during the Year 81 Average No. of Employees Underground Surface 12

Number of Man-shifts (8 hours each) during the Year: Underground Surface 26855
pc check 1566 dated 5-4-75

Total Inspection Fee 175.00 Number of Lost-time accidents during the Year None Man-hours worked 26,855

Compensation Insurance Carrier State

Date of this report 3/1/75 Signed O. L. Jahnke

By O. L. Jahnke

Title General Manager

This report must be submitted to the Colorado Division of Mines by March 1, 19 75

BM 8 (Rev. 10/74) (over)

B. of Mines

BoM 1975b

1845 Sherman Street
Denver, Colorado 80203

FILED FOR RECORD

Date NOV 5 1975

STATE OF COLORADO

BUREAU OF MINES
Department of Natural Resources
INFORMATION REPORT
No. I-27

Date July 17, 1975

County Dolores

RICO ARGENTINE — Leaching & Crushing (Mill)

Name of Operation — Kind of Operation

Rico Argentine Corporation — Box 158, Rico, Colorado 81332

Operator — Address of Operator

Rico Argentine Corporation — Box 158, Rico, Colorado 81332

Owner — Address of Owner

Orval Jahnke — Box 158, Rico, Colorado 81332

Person Locally in Charge — Address of Person in Charge

Rico Argentine Corporation — Continued from 1974

To Whom Shall Annual Report Be Sent — If New Operation, When Did Work Start

Producing X Development Exploration Part Time Idle

Products Gold and Silver — Monthly Rate of Production 10,000 ozs. Bullion-Gold and Silver

Value of Products $ Varies w/Market — Number of Days Operated 245 days - 1975 19

Men Employed: Total 25 Underground none Surface 25 Other

Location — The Rico Argentine Mill is located one mile north of Rico, Colorado on Hwy 145: Sec 25 T-39N R-10W N.M.P.M.
40 "

Several old mine dumps are being cleaned upand hauled to leaching pods.

Total Acres Mined — Acres Mined During Year — Acres Reclaimed During Year

Dump or Stockpile Area — Acres — Dump or Stockpile Area Reclaimed — Acres
No figures available until old dumps are cleaned up.

Description of Property & Operation — The same process is being used for leaching as in 1974 with the addition of another leach pod containing approximately 55,000 tons of raw ore. The new pod constructed in one of the old iron settling ponds that were used when the acid plant was operating. Some changes being made are an oxidation pod is being put on the hypalon covering consisting of a bottom layer of crushed gravel approximately two and one-halfft. to three ft. in depth. Some of the crushed ore from No. 1 pod has been moved to the No. 2 pod to reduce the depth of the leaching ore. The new pod will have considerably less height and will be kept at approximately twice the distance from the top of the berm to the ore base to prevent any slide material from overflowing the leach liquor. A 3% to 4% cyanide solution is used. Lime is added to the leaching liquor.
See Page No. 2

Surface Buildings — Surface buildings consist of: Crushing Plant, shops, mill, smelter room, numerous tanks, and warehouses.

Machinery, Compressors, Hoists, Etc. — Same as 1974:
1 - New 65-ton Truck added.
1 - New A.C. 3 1/2 yd. Front Loader

Type of Ground Support — Does not apply.

Ventilation — Does not apply.

Geological Formation — Does not apply.

Size of Vein or Deposit — Does not apply.

Miscellaneous (Obtain a Current Underground Map)

Thomas D. High
Inspector

4
District No.

BM 2 (Rev. 9-72)

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AUG 5 1975

A spray system has to be used to spread the leaching liquor on thepila; the soaker hose did not absorb enought oxygen from the atmosphere to oxidize the leach material.

A new bullion furnace has been built. The valUes are removed from the press and run through the furnace, then into a second smelter furnace where it is poured into bullion.

The recovery at present is approximately 65% to 70%. This is expected to increase with the new oxidation pods to hopefully 90% of the valUes in the raw ore.

Thomas D. High
Dist. Metal Mining Inspector-No. 4

B. of Mines

1313 Sherman Street
Denver, Colorado 80203

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NOV 14 1980

STATE OF COLORADO

DIVISION OF MINES
Department of Natural Resources
INFORMATION REPORT
No. I-168

RECEIVED
NOV 3 1980
COLO. DIVISION OF MINES

Date October 24, 1980
County Dolores

RICO ARGENTINE MINE	Mine
Name of Operation	Kind of Operation
Anaconda Copper Company	P.O. Box 158, Rico, Co 81332
Operator Phone	Address of Operator
Anaconda Copper Company Phone 967-7281	P.O. Box 158, Rico, CO 81332
Owner	Address of Owner
Orval L. Jahnke	P.O. Box 158, Rico, CO 81332
Person Locally in Charge	Address of Person in Charge
Anaconda Copper Company	Continued
To Whom Shall Annual Report Be Sent	If New Operation, When Did Work Start

Producing Development Exploration X Part Time Idle

Products Base Metal Mine — Monthly Rate of Production None this year

Value of Products $ Market Value — Number of Days Operated 240 days 19 80

Men Employed: Total 11 Underground Surface 11

Location Section 20 Township 40N Range 10W N.M.P.M.

The Rico Argentine Mine is located in Rico, CO.

Total Acres Mined Acres Mined During Year Acres Reclaimed During Year

Dump or Stockpile Area Total Acres Three (3) Acres Reclaimed During Year

Description of Property & Operation: The Anaconda Copper Company has acquired the property from the Argentine Mining Company. The operator has contracted Conners Drilling Company of Montrose to do surface core drilling. There was two drills drilling in different locations on the property this year.

Surface Buildings: 2 - Wood Frame Buildings

Machinery, Compressors, Hoists, Etc.:
2 - Drill Rigs with Tools
2 - Compressors
2 - Bean Water Pumps

Type of Ground Support: Does not apply.

Ventilation: Does not apply.

Geological Formation

Size of Vein or Deposit: 8 ft. vertical.

Miscellaneous (Obtain a Current Underground Map)

Joseph W. Slawes
Inspector

District No. L

CDM 2 (Rev. 2-77)

B. of. Mines

STATE OF COLORADO
DIVISION OF MINES
DEPARTMENT OF NATURAL RESOURCES
1313 Sherman Street
Denver, Colorado 80203

NORMAN R. BLAKE
Director

RECEIVED
COLO. DIVISION OF MINES

METAL & NONMETAL MINE OPERATOR'S ANNUAL REPORT
for the Year 1980

Number 107
County Dolores
Mining District

Name of Operation RICO ARGENTINE Kind of Operation Mine (Mine, Mill, Quarry, etc.)

Operator Rico Argentine Mining Company Ownership ( ) Lease ( ) Contractor ( )

Address (Local) Rico, CO 81332 Main Office Address

Owner Owner Address

Location of Property Section Township Range

Corporation ( ) Partnership ( ) Individual ( )
If a corporation, give name of state in which incorporated Property sold 8/27/80 to Anaconda Copper Co.

President Partner or Individual

Vice-President Partner

Secretary Partner

Treasurer Partner

Manager or Person in Charge Address
Telephone Number

Producing ( ) Developing ( ) Exploration (X) Part Time ( ) Idle ( ) Rehabilitation ( )

Principal Products

STABILIZATION AND RECLAMATION

Total Acres Mined 0 Acres Mined During Year 0 Acres Reclaimed During Year 0
Dump or Stockpile Area 0 (acres) Dump or Stockpile Area Reclaimed 0 (acres)

PRODUCTION FOR THE YEAR

Crude Tonnage (tons, yards, pounds) Produced during the Year 1980 Value $ None

List products separately, i.e., Gold, Silver, Copper, Lead, Zinc, or other minerals, Clay, Sand, Gravel, Stone, etc.

Product (oz., lbs., tons) Value $
Product (oz., lbs., tons) Value $
Product (oz., lbs., tons) Value $
Product (oz., lbs., tons) Value $
Product (oz., lbs., tons) Value $

LABOR STATISTICS

No. of Days Operated during the year 229 Average No. of Employees: Undergd. Surface 2

No. of Man-shifts (8 hours each) during the Year: Underground 3 Surface 458 Man-hours Worked 461

[illegible] 4/1/81

Total Inspection Fee $45.00 No. of Lost-time Accidents during the Year None No. of Fatalities None

Compensation Insurance Carrier Aetna

Date of this report 2/6/81 Signed

Anaconda paid ck # [illegible] $30.00 6/8/81

By: Orval L. Jahnke

Title General Manager-Rico Project

This report must be submitted to the Colorado Division of Mines by March 1, 1981.

CDM 8 (Rev. 10/78) (over)

Rico Argentine [illegible]

B. of Mines

1313 Sherman Street
Denver, Colorado 80203

STATE OF COLORADO

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FEB 19 1982

DIVISION OF MINES
Department of Natural Resources
INFORMATION REPORT
JO-19

Date 1-29-82
County Dolores

Name of Operation: Rico Project
Kind of Operation: Mine

Operator: Anaconda Copper Co.
Phone:
Address of Operator: P.O. Box 158 Rico, Co. 81332

Owner: same
Phone 967-7281
Address of Owner: same

Person Locally in Charge: Orval L. Jahnke
Address of Person in Charge: same

To Whom Shall Annual Report Be Sent: Anaconda Copper Co.
If New Operation, When Did Work Start: Continued

Producing | Development ✓ | Exploration ✓ | Part Time | Idle

Products: Base Metals
Monthly Rate of Production: None
Value of Products $: Market Value
Number of Days Operated: 240 1982
Men Employed: Total 9 Underground 3 Surface 6

Location: Section 20 Township 40N Range 10W
The mine is located at Rico, Co.

Total Acres Mined ______ Acres Mined During Year ______ Acres Reclaimed During Year ______
Dump or Stockpile Area: Total Acres 10 Acres Reclaimed During Year ______

Description of Property & Operation: The company personel are over seeing work done by contractors. J. S. Redpath is cutting drill stations, and doing clean-up work. Boyles Bros Drilling has contracted the exploration drilling, both underground + Surface. The company plans to contract out the building of a mine water treatment plant this summer.

Surface Buildings: Same as 1981 Report.

Machinery, Compressors, Hoists, Etc.: Equipment Furnished by Contractors.

Type of Ground Support: Square Sets, Posts + Caps, Bolts + Mats, Pillars

Ventilation: Natural

Geological Formation: Rico

Size of Vein or Deposit: 8 ft Vertical

Miscellaneous (Obtain a Current Underground Map)

Inspector: Joseph W. Davies
District No. 4

COM 2 (Rev. 2/77)

B. of Mines

83

Rico Project
Name of Operation

Mine
Kind of Operation

Anaconda Copper Co
Operator Phone

P.O. Box 158 Rico, Co 81332
Address of Operator

Same
Owner Phone 967 7281

Same
Address of Owner

Orval L. Jahnke
Person Locally in Charge

Same
Address of Person in Charge

Anaconda Copper Co
To Whom Shall Annual Report Be Sent

Continued
If New Operation, When Did Work Start

Producing Development Exploration ✓ Part Time Idle

Products Base Metals

Monthly Rate of Production none

Value of Products $

Number of Days Operated 240 limited 1983

Men Employed: Total 8 3 Underground 8 3 Surface

Location: Section 20 Township 40N Range 10W

The mine is located at Rico, Co

Total Acres Mined Acres Mined During Year Acres Reclaimed During Year

Dump or Stockpile Area: Total Acres 10 Acres Reclaimed During Year

Description of Property & Operation: The company completed their exploration drilling program in March. At this time the company has 3 people remaining for maintenance. No other activity is planned in 1983. The water treatment plant the company was going to construct in 1983 has been moved to 1984. The poor economic conditions effected this decision. The company is primarily interested in an molybdenum deposit on the property.

Surface Buildings:
1 - Mill Building
1 - Shop Building
4 - Storage Buildings

Machinery, Compressors, Hoists, Etc. ——

Type of Ground Support: Square Sets - Posts & Caps - Bolts + Matts - Pillars

Ventilation: Natural

Geological Formation: Rico

Size of Vein or Deposit: 8 ft Vertical - with replacement ore bodies

Miscellaneous (Obtain a Current Underground Map)

Joseph W Davis
Inspector

4
District No.

COM 2 Rev. 2 77

CDH Files

RECEIVED

AUG 0 1 1988

WQCD, PERMIT SECTION

COLORADO DEPARTMENT OF HEALTH
Water Quality Control Division
4210 East 11th Avenue
Denver, Colorado 80220
(303) 331-4590

APPLICATION FOR TRANSFER
AND ACCEPTANCE OF TERMS
OF A COLORADO PERMIT

I hereby apply for transfer to me of this Colorado Permit No. CO-0029793 which was issued to Anaconda Minerals Company. I have reviewed this permit and accept responsibilities, coverage and liability, effective August 30, 1988.

NEW OWNER/OPERATOR Rico Development Corporation, a Colorado Corporation

Facility Name St. Louis Tunnel Mine

Mailing Address P. O. Box 130

City Rico State Colorado Zip Code 81332 County Dolores

Telephone Number (303) 967-2793
Area Code

Authorized Agent Marion D. Sell
(Print)

Signature Marion D. Sell

Title President

Date July 26, 1988

AS previous owner, I hereby agree to the transfer of the above-referenced permit and all responsibilities thereof.

PREVIOUS OWNER/OPERATOR Anaconda Minerals Company

Facility Name St. Louis Tunnel Mine

Authorized Agent T. H. Parker or Omer Adams
(Print)

Signature Omer Adams

Title Vice President

Date

EPA CLOSEOUT COPY

URS Project No. 41881
Log No. 41, 10, B1013
☐ Original ☐ Copy

ANACONDA Minerals Company
555 Seventeenth Street
Denver, Colorado 80202
Telephone 303 293 4000

Stan
Judy / Sandy
JED
CDH Files

August 29, 1988

RECEIVED
SEP 01 1988
WQCD, PERMIT SECTION

Mr. James B. Horn
District Engineer
Water Quality Control Division
Colorado Department of Health
222 So. 6th Street, Room 232
Grand Junction, Colorado 81501

RE: CPDES Permit No. CO-0029793, Annual Inspection Report

Dear Mr. Horn:

This letter is written in response to your July 29, 1988 letter and July 6 site inspection of our wastewater treatment facility located near Rico, Colorado. In your letter, you confirmed that the facility was "....being properly operated" as stated in the June 30 annual inspection report. You then you went on to provide three recommendations. The following is our response to your three recommendations:

1. "Accumulation of solids in the first two settling ponds"

   We agree that there is an accumulation of solids within the first two settling ponds. That is the purpose for which these ponds were designed. In time, it will become necessary to remove the solids in order to maintain the treatment efficiency of the pond system. However, based on data collected at the pond discharge, it appears that the system is functioning very well at the present time and is in full compliance with the suspended solids limit of 20 mg/l avg. and 30 mg/l max. In fact, the discharge normally carries TSS values well below the permit limit, in the range of less than 2 mg/l. Therefore, even though there may be some short-circuiting occurring in the first two ponds, any carry over of solids is not being reflected at the discharge point.

   Additionally, it should be noted that most of the solids contained in the first two ponds are unreacted lime associated with relatively poor treatment efficiencies obtained by the old treatment system which was replaced by Anaconda in the fall of 1986. The new lime slaking system has markedly reduced the "wasting" of unreacted lime in the settling ponds and should extend their usable storage life.

2. "Pond leakage"

Installation of a flow measuring device at the St. Louis Tunnel would be of marginal value in increasing our understanding of the potential impact of pond leakage. As you are aware, these settling ponds, located along the Dolores River, were constructed many years ago in unconsolidated materials underlain by a major geothermal fault. Anaconda recognized the complex geology associated with this area soon after our purchase of the property in the early 1980's and initiated a major water quality study of the Dolores River system to better understand the relationship of the settling ponds to the River. The results of our investigations are on record in your Division offices in Denver. As you will note from review of these extensive water quality investigations, there is no measurable impact on water quality in the Dolores River adjacent to the treatment ponds.

3. "Discharging geothermal wells"

In the early 1980's Anaconda capped the existing artesian wells located along the access road to the treatment facility. Recently, a couple of the capped well casings apparently failed. While the artesian flows from these wells may have added increased dissolved solids to the surface water system, the increase was most likely minimal and of little consequence. The Dolores River intersects a geothermal fault zone which appears to be the source of the artesian flows which naturally flow into the river via numerous hot springs located along the river's banks and within the actual substrate of the streambed. This phenomenon is evidenced by the occurrence of bubbles of carbon dioxide in the river substrate and throughout the lower series of treatment ponds.

As I discussed with you on August 3, we agreed that the wells should be capped. On August 8, we installed a new ditch and associated culvert which diverted the artesian flows into the permitted treatment pond system until the wells could be capped.

With the assistance of an outside drilling contractor, both wells were grouted and recapped on August 15. As an added safety precaution, we intend to maintain the drainage ditch even though the wells are no longer flowing. Should any future seepage from the well heads develop, the flows will be diverted directly into the final treatment pond for treatment prior to discharge into the Dolores River.

Jim, I would like to express my appreciation for the assistance you have given Anaconda and the new owner, Rico Development Corporation, on this matter over the last couple of weeks. Hopefully, we have addressed the recommendations cited in your letter and resolved the problems associated with the artesian wells. If you would like to discuss these matters further or need additional information, please don't hesitate to give me a call. I can be reached at 293-7938.

Sincerely,

Robert L. Dent
Minerals Environmental Manager
(303) 293-7938

RLD/das

cc: Mr. Wayne Webster and Marion D. Sell
Rico Development Corporation
P.O. Box 130
Rico, Colorado 81332

Neal Muldoon
Muldoon Electric
P.O. Box 25
Rico, Colorado 81332

Ms. Judy Bruch
Permits and Enforcement Division
Colorado Department of Health
4210 East 11th Avenue
Denver, Colorado 80220

CDH Files

Water Treatment System for St. Louis Tunnel
Built by Anaconda 1954

Discharge from Blaine Tunnel redirected underground to St. Louis tunnel.

Complete file - see WQCD

Brad Austin

URS
A PROFESSIONAL SERVICES ORGANIZATION

URS CONSULTANTS, INC.
1099 18TH STREET
SUITE 700
DENVER, COLORADO 80202-1907
TEL: (303) 296-9700

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COLUMBUS
PARAMUS
AKRON
BUFFALO
NEW ORLEANS
ATLANTA
BOSTON
VIRGINIA BEACH
PITTSBURGH

Januray 20, 1995

Mr. Robert Heise
Work Assignment Manager
U. S. Environmental Protection Agency
Region VIII, Superfund Management Branch
999 18th Street
Suite 500
8HWM-WAM
Denver, Colorado 80202-2405

Subject: **ARCS VI, VII, and VIII, Contract No. 68-W9-0053, WA# 21-8JZZ**
Re: Close out of the Rico-Argentine, Rico, Colorado, Site Inspection Prioritization

Dear Mr. Heise:

As per EPA's instructions, we have closed out Rico-Argentine, Rico, Colorado, Site Inspection Prioritization (SIP). As this site is to be reassigned, possibly to URS, as an Expanded Site Inspection (ESI) project, the site files will be kept at URS. This will allow the URS investigator rapid access to the working file data. When the project assignment is decided, URS will dispose of the files appropriately.

If you should have any questions concerning this close-out, please feel free to contact me at (303) 296-9700.

Very truly yours,

URS CONSULTANTS, INC.

Michael V. Carr

Michael V. Carr
Project Manager

cc: Pat Smith/EPA Region VII — w/inventory only
Metha Leslie/URS/Denver — w/inventory only
ARCS File/URS/Denver

URS
Project No. 41881
Log No. 41 ,20 ,B1027
☐ Original ☐ Copy

41881.41
PMO\Closeout\Correspd\RicoArgt.SIP:mjl

SITE INSPECTION PRIORITIZATION INDEX

1) Site Historical Information

● reports, correspondence, press clippings, interviews, maps, schematics, permits, ownership records, waste characteristics, analytical data

2) Correspondence

3) Field Information

● log books, site access agreements, photographs and negatives, field sampling plan

4) Health and Safety

● site health and safety plan, MSDS

5) General Site Characterization

● geology, hydrology, hydrogeology, meteorology, maps

6) Interpretative or Final Reports

7) Target Information

● ground water users, surface water users, population data, wetlands maps, land use maps, wind roses

8) QA/QC

41881 41-10-B1012 DATE: MAY 25, 1994	FROM: U.S. DEPT. OF AG.	TO: URS	SUBJ: INFO RE NEW OWNERS OF RICO DEVELOPMENT CORP'S HOLDINGS
41881 41-10-B1014 DATE: 1915-1983	FROM: COLORADO BUREAU OF MINES	TO: PUBLIC	SUBJ: INSPECTOR'S DAILY REPORTS/INFORMATION REPORTS/OPERATOR'S ANNUAL REPORTS
41881 41-10-B1013 DATE: 1984-1988	FROM: CDH	TO: PUBLIC	SUBJ: SITE INFORMATION FROM COLORADO DEPT OF HEALTH FILES
41881 41-20-B1027 DATE: JAN 20, 1994	FROM: URS	TO: EPA	SUBJ: LETTER RE CLOSEOUT AND TRANSFER OF FILES
41881 41-30-B1015 DATE: MARCH 1994 NOTES: 40 PAGES	FROM: URS	TO: URS	SUBJ: LOGBOOK #268 (CARR)
41881 41-50-B1016 DATE: SEPT 27, 1993	FROM: CDH	TO: PUBLIC	SUBJ: CLASSIFICATIONS AND NUMERIC STANDARDS FOR SAN JUAN RIVER AND DOLORES RIVER BASINS
41881 41-50-B1020 DATE: 1905	FROM: USGS	TO: PUBLIC	SUBJ: EXCERPTS FORM "GEOGRAPHY AND GENERAL GEOLOGY OF THE RICO QUADRANGLE"
41881 41-50-B1018 DATE: AUG 1974	FROM: U.S. DEPT. OF INTERIOR	TO: PUBLIC	SUBJ: EXCERPTS FROM "GEOLOGY AND ORE DEPOSITS OF THE RICO DISTRICT"
41881 41-50-B1019 DATE: 1900	FROM: USGS	TO: PUBLIC	SUBJ: EXCERPTS FROM "GEOLOGY OF THE RICO MOUNTAINS, COLORADO"
41881 41-50-B1017 DATE: AUG 4, 1975	FROM: STATE OF COLORADO	TO: PUBLIC	SUBJ: RECONNAISSANCE ENGINEERING GEOLOGY REPORT FOR PLANNING DISTRICT 9
41881 41-60-B1028 DATE: MARCH 1994	FROM: URS	TO: URS	SUBJ: CERCLA ELIGIBILITY WORKSHEET
41881 41-70-B1026 DATE: APRIL 6, 1994	FROM: STATE OF COLORADO	TO: PUBLIC	SUBJ: COLORADO WELLS, APPLICATIONS AND RESOURCES/WATER RIGHTS REPORT
41881 41-70-B1025 DATE: 1990	FROM: U.S. CENSUS BUREAU	TO: PUBLIC	SUBJ: HOUSEHOLD, FAMILY AND GROUP QUARTERS CHARACTERISTICS/LAND AREA AND POPULATION DENSITY
41881 41-70-B1023 DATE: MAY & JUNE 1994	FROM: U.S. DEPT OF INTERIOR	TO: URS	SUBJ: INFO RE FEDERALLY LISTED SPECIES NEAR SITE
41881 41-70-B1024 DATE: APRIL 13, 1994	FROM: COLORADO NATURAL HERITAGE PROGRAM	TO: URS	SUBJ: INFO RE SIGNIFICANT NATURAL COMMUNITIES AND RARE, THREATENED OR ENDANGERED SPECIES
41881 41-70-B1022 DATE: JUNE 6, 1994	FROM: STATE OF COLORADO	TO: URS	SUBJ: INFO RE STATE SENSITIVE WILDLIFE SPECIES NEAR SITE
41881 41-70-B1021 DATE: MAY 25, 1994	FROM: U.S. DEPT OF INTERIOR	TO: URS	SUBJ: WATER QUALITY AND SEDIMENT DATA ON THE DOLORES RIVER
41881 41-80-B0662 DATE: OCT 11, 1994 NOTES: 1 VOL	FROM: URS	TO: EPA	SUBJ: REV 0: SITE INSPECTION PRIORITIZATION/RICO-ARGERNTINE, RICO, COLORADO

EPA CLOSEOUT COPY

COMPOSITIONS

#268 41881.41
Rica Argentine Mine
M.V. Carr

COLLEGE RULED

RECYCLED

"Recycle For Our Future"

10¼ IN. x 7⅞ IN.
80 SHEETS
NO. 77461

Roaring Spring. • Roaring Spring, PA 16673 • MADE IN USA

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Project No. 41881
Log No. 41 30 B1015
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URS CONSULTANTS, INC.
1099 18th Street, Suite 700
Denver, Colorado 80202
Tel: (303) 296-9700
FAX: (303) 296-6117

A PROFESSIONAL SERVICES ORGANIZATION

MICHAEL V. CARR
ENVIRONMENTAL SCIENTIST

INFORMATION RECORDED IN THE FRONT OF LOG BOOKS (OPTIONAL)

- serial/model #s of equipment (meters)
- formulas, constants, example calcs
- useful phone #s
- site address

DAILY RECORDING REQUIREMENTS

* - initials and date (top of every page) prenumbered
- start time
- weather

* - decon methods (you may cross reference a previous days method if identical)
- personnel present on site
- ppe

* - signature of individual recording info

* - equipment/procedures used [illegible]

* - sample descriptions (time, depth, volume, containers, preserv, etc.)
- QC samples (field and lab)
- observations odors, liquids, anything health & safety
- field parameters pH, etc
- maps/photos drawn or taken describe each photo as it is taken, can take labels w/ you and stick to log book page
- form #s*
- lost/voided paperwork write down all numbers that are to be voided

* When using a field form information recorded in the field does not need to be written twice. Cross reference the field form # in the log book and record the information only on the appropriate field form.

DO NOT LEAVE ANY BLANK SPACES/PAGES.

If a page is accidentally left blank or there is unused space at the end of a day's entry draw a diagonal line through the space and initial and date the line.

TDM NO.: ______
PHOTO NO: ______
PROJECT NAME: ______
PROJECT NO.: ______
PHOTOGRAPHER: ______
LOCATION: ______
DATE/TIME/DIRECTION: ______
ID OF PERSONS IN PHOTO: ______

COMMENTS/DESCRIPTION: ______

COD980952519

Latitude 37°42' 05" SE 1/4 Sec. 25 T 40N R11W.
Longitude 108° 01' 39"

000001

3/22/94 Michael V. Carr

Obtained agreement from Ettenger to start work on this site without a signed WAF or accounting sheets.

0900 Called Gene Borzick - he will pull CERCLIS files.

- Gene also looked into ERB files - no info on Rico Argentine
  Andrea McIntosh confirmed this.

1000 Called Heise about access problems to RCRA files - he said to call Nick Robinson (293-1676)

1130 Nick Robinson called back - no RCRA files on this site.

1200 Called Glenn Mallory at CDH - he said a PA was done in 1989. Call Jo Chavez or Julie Rodriquez to make appt. to see files. Also need to send/fax a letter request.
PADOLRIC.

3/22/94 MVC

000002

3/23/94 Michael V. Carr

Wed. 1130 Arrived LAI to review files ≈ 2 inches thick

Stauble was EPA Project Officer

E&E - Margaret Babits 1984

CDH - WQCD has files from Anaconda Minerals Co. which took over site in 1980. They have a NPDES permit for discharge from St. Louis Tunnel. (CO-0029793 issued in 1982).

Located on portions of Sec. 24 & 25, T40 N, R11W.

3/23/94 MVC

Thur

000023

3/24/94 Michael V. Carr

Thur 1230 Called Census Bureau & ordered population data.

1500 Called Carl Mount at Colo. Dept. of Minerals & Geology - left message.

1615 Andrea McIntosh called - she doesn't have anything on Rico-A & doesn't know about the spill list/wasteLan II. Try calling Nick Robinson back about it.

MVC 3/24/94

000024

3/25/94 Michael V. Carr

Spent large part of day at USGS Library & buying topos.
Library had surprisingly amount of info on Rico area.
✓1) Reconnaissance Engineering Geology Report for Planning District 9, State of Colo., Colo. Geol. Survey, prepared for CGS & Colo. Div. of Planning by F.M. Fox & Associates, 1973
Found & copied selected pages.
✓2) USGS Annual Rpt, No. 21, Part 2, p. 15-165, "Geology of the Rico Mtns, Colo." by Whitman Cross and Arthur Coe Spencer, 1900
Found & copied selected pages.
✓3) USGS Professional Paper 723. "Geology & Ore Deposits of the Rico District, Colorado." Edwin T. McKnight - 1974.
Found & copied selected pages.
✓4) USGS Folio 130. "Discription of the Rico Quadrangle" by Whitman Cross and F.L. Ransome 1905
Found & copied selected pages.
5) Identification & Remediation of a Mine Flooding Problem, Rico, Colo with a Discussion on the Use of Tracer Dyes. M.W. Davis Colo. Geo. Survey 1991. — Could not find.
~~6)~~ CGS.; Geology of the Dove Creek Area
No - too far west R16W + R20W

3/25/94 MVC

GC0[illegible]

3/28/94 Michael V. Carr
COH called - PA file on Rico is ready

3/28/94 MVC

CC0R...6

3/29/94 Michael V. Carr

Arrived CDH to review files

Very little new in the site file.

- a different geology ref: Van Derwift, J.W. 1947. "Mineral Rscs of CO". 403(271) C71m

- CDH copy of E/E SAR is slightly different and has a date of Jan. 25/1985 on it. (CERCLIS file = 12/21/89)

Open file for County doesn't have any extra info.

1300 Went back to USGS - couldn't find above ref - looked like it was checked out.

1400 Went to ESIC - no wetlands maps available for area.

Went to FEMA - couldn't find anyone to help me.

1600 Back in office - Carl Mount had called 866-3567

Called back - busy - left message.

1630 Mount called back

Jim Stevens - handles southern Colorado. - However - no permit so he doesn't believe there is anything for me to look at

- Mount suggested I call Forest Service

✓BLM (Charles Fair (719) 275-0631)

Also try B of Rec in Durango (Stan Powers (303) 385-6555)

3/29/94 MVC

000037

7/30/94 Michael V. Carr

0900 Called Jim Stevens at CDMG - No permit or files on the site. Suggested I call Office of Mines, Joe Nugent 880-2983.

- Noticed a Rico Ranger Station on the 7.5" topo. Forest Service may have interest in mine.

8/30/94 MVC

000008

4/1/94 Michael V. Carr

Faxed map & request to Katie Pague at Colo. Natural Heritage Program Fax # 492-5105

Called Brian Hyde (866-3441) at Wtr Conservation Board of Dept. of Nt'l Rscs for FIRM maps - left message.

Called Kathleen Reilly (692-3573) CDH WQCD at wellhead protection districts - left message.

Spent 1 1/2 hours w/ Tony Selle - EPA's GIS specialist - he agrees that they probably cannot help us in site assessment except for major metro areas such as Denver & Salt Lake. Would like to see us contribute data we collect & give it to him to build databases. Start dialogue w/ Pat Smith, Heise, Paul Arell.

1100 Called Kathleen Reilly back - she said that Brighton and Ft. Lupton are two areas that have been proposed as Wellhead Protection Areas for Classification but are not yet protected areas. Nothing for Rico area.

1430 Went to State Eng to begin copying well logs.

4/1/94 MVC

000009

4/5/94 Michael V. Carr

1530 Called Dave Weber (291-7231) & left message. He will be in tomorrow morning. I left message about what I need.

1535 Called BLM - Charles Fair - (719) 275-0631 - he said to call regional office in Montrose - District Geologist (hardrock) Ben Sprowse.

1540 Called Sprowse - (303) 249-7791 - site is not on BLM land so no info. Could try BLM Records of Survey in Denver office or try Dolores County Courthouse for ownership records.

1550 Called Joe Nugent - Dept. of Minerals & Geology - Office of Mines 880-2983 They have a file on the R-A, last inspected after remediation. Office at 1313 Sherman has file on microfiche.

1600 Called B. of Reclamation in Durango - Stan Powers - (303) 385-6555 Back in office on Thursday. - Call back

4/5/94 MVC

4/6/94 Michael V. Carr

0930 Dave Weber called back - they can provide info that Heritage may not have such as sensitive environments/wetlands. Heritage can provide plants/insects/communities that CDOW doesn't have. They will overlap on wildlife sightings. Call regional biologists.

1030 Called Bob Clark - CDOW Montrose - (303) 249-3431 fax 249-2857 Call back Monday.

1105 Called Janet Coles - Colo. State Parks, Colo Natural Areas Inventory 866-3203 x 330 Left message to call me back.

1110 Called Forest Service office in Durango - referred me to Dolores

1112 Called Forest Service office in Dolores - (303) 882-7296 John Reidinger Call back this PM.

4/6/94 MVC

C00011

4/11/94 Melinda V. Carr

1500 Bryan Hyde called back (Colo. Wtr. Conservation Board 866-3441)
Fax 866-4474

He doesn't think there is any info for the Rico area. There was a CGS report on a creek that channeled into a mine & emerged into the Dolores River. I think I saw that report at the USGS & it is outside the Rico TDLs. He is locating the article anyway - for someone else - and I can see it when I go over to his office for Brighton - Fort Lupton. There is also an "approximate map" that is probably of little use.

Janet Coles called back - Colo. Natural Areas - Heritage Program was started in her department before being split off. She would only duplicate their info except for geological areas of interest which are not of use to us.

4/11/94 MVC

000012

4/25/94 Michael V. Carr

Recieved Colo. Natural Heritage Program database search results.

Not much in database - a few riparian plant/forest communities

Also - on 4/20/94 I talked to Lee Carlson of FWS. I faxed him maps of the site w/ request a list of T&E species

4/25/94 MVC

000043

5/16/94 Michael V. Carr

Finished reading geological reports - no discussion of mercury. Went back to B. of Mines

- Long discussion w/ Joe Nugent about area. He doesn't believe mercury is from mine - they are happy with ongoing reclamation. He thinks illegal dumping is the cause and told EPA that when fish samples were high.
- Searched microfiche files thru 1984 and a very thin file w/ reports thru 1987. No mercury but they did run a cyanide loop.
- Oct 24, 1986

  Contractor, CDK, tearing down old buildings & structures & sub-grading. Material & chemicals useful to other mills was transported & the rest taken to approved dump sites. Selling mill at Blaine Adit & site property is for sale.
- Oct 2, 1987 State of Colo., Div. of Mines Information Rpt by Joseph W. Davies

  Sec 20 40N 10W

  Anaconda Minerals (R.L. Dent, Env. Manager, 555 17th St, 293-7938)

  No activity scheduled for 1987. Old mill ~~with~~ removed as well as leach pad/plant bldgs & fixtures. All haz. waste removed & area subgraded. Installed small wtr treatment plant & settling ponds.

5/16/94 MVC

000014

5/17/94 Michael V. Carr

Doesn't pass CERCLA Elig. Form -

Went thru well listings

3 household in Sec 25.23 ≈ 1 mile upgrad. from Rico, slightly up & across River from settling ponds

1 industrial owned by Rico Devel. at upper end of settling ponds

1 other near settling ponds owned by CDOT

1 household in Rico

1 uncategorized in Rico

Surface wtr diversions

12 w/in 15 miles downstream - domestic, irrigation, industrial, stock, fire

1140 Called Stan Powers - out to lunch

1145 Called John Reidinger - out in field

1150 Called Ben Sprouse back - BLM Montrose geologist, Mercury wasn't used at R-A as far as he knows, also doesn't think mineralogy is correct for elevated natural mercury compounds. A theory for McPhee is maybe placer mining before reservoir was built but he doesn't know of any history of that.

1500 Stan Powers

- Bureau of Rec conducted water & sediment sampling in Silver Creek and Dolores River & some tributaries in 90, 91, 92, 93.
- Mercury detect. limit was 0.05 μg/l.
- Mercury in sediments in Silver Creek
- Silver Creek is pretty bad w/ metals loading. Tailings go into creek & ponds on top of tailings leak into creek.
- Dolores R. is not as bad. CDH controls discharge from ponds thru NPDES permit

~~- No mercury in wtr samples down to McPhee. Sediment shows background levels until a tributary near McPhee which contains elevated mercury. This tributary has a~~

5/17/94 con't. MVC

C00015

- Recent study suggests that decaying matter in McPhee (due to poor contractor performance during construction) makes mercury more bioavailable while cold high-altitude streams don't contain organic matter to convert the mercury. But Stan doesn't think problem w/ mercury is from R-A district.
- Study was done on power plants on 30km radius - mercury doesn't appear so its going somewhere. R-A is downwind in storm path from Navajo power plant.
- Call Mark Lundquist at MK - data package from sampling was sent to him on 1/12/94.
- Call Jim Yahnkey in B-of-R in Denver. He did analytical analyses.

1520 Called Jim Yahnke 236-3778
- Silver Creek is bad. But after confluence no mercury in wtr. samples and only background in sediment samples.
- Mercury in sediments near Rico and in Silver Creek.
- Tributary above McPhee contains elevated mercury. There is an asphalt plant and timber treating up the tributary.
- Samples analyzed by USGS labs, Berringer Lab & Weston which had QA/QC problems with mercury.

1545 Went to see Pat Smith
- She didn't intend focus to be on attribution of mercury in reservoirs
- She is concerned w/ metals loading in Silver Creek/Dolores

5/17/94 MVC

C00016

5/18/94 . Michael V. Carr

0810 Called Yahnke back - he will get Stan's OK & send report on disc. They have found mercury throughout the basin - he is leaning toward airborne source (ie: powerplants).

Called Bob Clark - CDOW Montrose (303-249-3431)

- Actual search for T&E should be thru Feds (FSWS)
- State Species of Concern provided by CDOW - search will take > 30 days
  - Send request to Ruth Carlson in Durango (biologist)
- He doesn't know of any species of interest in Rico area

1000 Called Lee Carlson at US F/W - he had forwarded my map & request to Grand Junction - ~~Mikke~~ Tucker/Terry Ireland 243-2778

1005 Called Mike Tucker - gave me to his supervisor Keith Rose. Keith wasn't very cooperative - he insisted on a 6 month process dictated by law to do an assessment. I will fax a request to him explaining I only need background type info (he says this info is good only for 90 days).

Called Wtr Quality Control Division in Denver 692-3500

Pat Nelson - she was very helpful.

- site has permit
- site is in violation, site is in major facility - an EPA category.
- weekly sampling data goes into PCS (permit compliance system)
  - call Debora Griffith 294-1382 in NPDES branch of EPA Wtr Management.
- reported monthly in DMR (discharge monitoring report)
- W. Q. C. Commission (Marla Beibersting 692-3525) has individual stream quality standards.

1130 Called Mary Jahnke in Rico - they have one well used for drinking water. Used to use spring, drilled well in 1990.

Called CDOT in Durango 385-1600, left message.

C00047

5/10/94 MVC

Neighbor (Maxwell) also uses a well for drinking wtr source. Town Hall 967-2861.

1340 Called Ruth Carlson CDOW in Durango 247-0855 - left message.

Called Debara Griffin - left message

Called Marla Beiberstine - left message

1420 Ted Vickers, Durango CDOT, called back. Well was installed for toilets, washbasins in maintenance shop but only used for a couple of years. Wtr was too mineralized & plugged pipes. Well abandoned & city wtr used in shop now.

1630 Called Nancy McGonigal at Durango Forest Service (works with John Raidinger). (303) 882-7296.

Property has been sold again by Rico Devel. Corp to a syndicate from Phoenix. She will meet w/ them on Friday & send me a letter next week on who they are & what they plan on doing w/ property - probably real estate.

Forest Service doesn't have any other concerns about R-A.

Forest Ranger Station is seasonally staffed by volunteers for tourist info

5/10/94 MVC

000__8

5/19/94 Michael V. Carr

Cont w/ draft. & phone calls

Jim Yahnke called - Stan is sending him the 1993 sampling data, he will update his report & send it.

He looked at old report - he does show surface water loading of mercury at S.C/D.R confluence but not at tailings area.

He thinks infiltration on most Colorado tailing piles is very low because they seal themselves off with fines. Any erosion would allow infiltration though.

0900 Called Marla Beilestine at W.Q.C Commission - she will send stream standards for Dolores River Basin including Silver Creek.

0905 Called Ruth Carlson - CDOW Durango. Not too friendly - busy.

She will pull some info together, including fishery, and send it out next week.

- Wilddata is big cumbersome database - she would need to charge me to access it & doesn't think its worth it.

~~Barbara~~ Debora Griffith called back. Need Freedom of Info Act request addressed to Lonnie Wiley. 8th Floor (video elevators)

1500 Called Bob Dent at Anaconda - he will call back tomorrow

1505 Called HK - Marta said Mark Lundquist no longer works for them - Susan Ford works on the reservoir problem. She is out till next week but will call me.

5/19/94 MVC

C00019

5/26/94 Michael V. Cam

Con't w/ typing draft.

Bob Dent (Anaconda) called.

- Nothing much to add - he hasn't been on the site for >10 years
- They were drilling for moly. Mostly uphill from ponds & a little just inside the adits.
- They did a lot of environ work while there - plugging adits, capping flowing wells near ponds, etc.

5/26/94 MVC

--C00020

5/23/24/94 Mulief V Cun
Con't with draft writeup.

5/29/99 MR

000021

5/25/94 Michael V. Carr

	J	F	M	A	M	J	J	A	S	O	N	D	
Precip	26	29	27	23	18	16	42	39	32	31	23	25	= 326 = mean annual precip = 12.8"
Evap	0	2	12	26	53	49	55	42	33	29	9	0	
	26	24	15	0	0	0	0	0	0	2	12	25	= 104 = net precip = 4.1"

Census data

92 residents in Rico (2.09/household)

123 residents in Rico division (2.12/household)

1504 " " Dolores Cty (2.59/household)

From topos:

0-1/4	= 0 dots	= 0	102
1/4-1/2	= 3 dots	= 7.8	
1/2-1	= 80% of Rico + Horse Gulch (Yalakes)	= 76	
1-2	= 20% of Rico	= 18	
2-3	= 0	= 0	
3-4	= 0	= 0	

Paul Arrell called - don't need Freedom-of-Info. Act letter to access EPA wtr. Management data. Call Janet Fujita to set up time since Debora Griffin is out of office. 293-1594. 4th floor - recep.

- Called Janet - 9:00 AM tomorrow.

5/25/94 MVC

CCC022

5/26/94

0900 Met w/ Janet Fujita for Water Management Division files
- Apparently some wrangling between EPA & CDH as to who can permit the site.
- This was mostly an enforcement file.

Colorado Discharge Permit System (CDPS) # CO-0029793
renewed 2/1/94

Parameters	30 day avg	Daily max	Collection freq.
Flow (MGD)	2.6 (design flow)	Report	Daily
TSS (mg/l)	20	30	Weekly
pH	–	6.5-9.0	Daily
Total Rec. Cadmium (mg/l)			weekly
thru 1/31/95			
Jan-April	.0024	.0048	
May-July	.0055	.011	
Aug-Dec	.0075	.007	
beg. Feb 1/95	.0004	Report	
T.R. Copper			weekly
thru 1/31/95	.03	.06	
beg. 2/1/95	.024	Report	
TR Lead	.0099	Report	weekly
TR silver			weekly
thru 1/31/95			
Jan-April	.0002	.0004	
May-July	.0006	.0012	
Aug-Dec	.0004	.0008	
begin 2/1/95	.0001	Report	
TR Zinc	.45	.88	weekly
thru 1/31/95			
beg 2/1/95	.237	Report	

Report summary on monthly DMR (EPA form 3320-1)

NPDES is in effect until 12/30/93 when State took over
Treatment system became fully functional April 1, 1984; amended 1986.
19 Ponds.

DMR Review 1/89 – 3/90

Flow	1.1	.87
pH max	8.12	7.7
pH min	6.8	6.9
TSS max	18	60
TSS month max	11.25	33.75

000028

5/26/94 con't MVC

Ag (#/day) max	.01	.01
month max	.01	<.001
Zn	1.66	2.13
	1.24	1.435
Cd	.18	.0104
	.091	.0079
Pb	.019	.033
	.054	.0225
Cu	.03	.04
	.03	.025
TDS (mg/l)	1878	1352

Whole Effluent Toxicity (WET) testing added 9/6/89, first WET testing in 1st quarter 1990 demonstrated that effluent was acutely toxic (50% or more mortality to Ceriodaphnia dubia and/or fathead minnows

Discharge is to Segment 2 of Dolores River.

Recreational Class 2

Aquatic life Class 1 (cold)

Agricultural use

Water supply

Required to meet WET by 6/4/93.

Permit expires 9/30/95.

- 9/1980 NOV & C&D order issued by CDH, amended 12/17/81.
  - exceeded zinc, copper standards
  - led to wtr. treatment system April 1, 1984.
- 11/12/1984 NOV to Anaconda Mining Company for cadmium
- Rico Argentine Mining Co was a division of Crystal River Exploration and Production Co.
- 5/5/93 Industrial Wastewater Inspection Rpt by Jim Horn.
  No haz waste onsite
  Wastewater flowing into cyanide basin which may have torn liner.
  Silver loading in 12/92 but passed WET test.
- 6/18/93 Letter from James B. Horn, District Eng, CDH.WQCD to David Sell of RDC. NOV of Colo. W.Q.C. Act due to late filing of DMR and silver loading. Notes wastewater into cyanide basin.
- 8/30/93 CDH letter to RDC from Kathleen L Kalaner, Industrial Enforcement Engineer, Permits & Enforcement Section, WQCD.
  2nd Quarter 93 WET failed

In violation of:			Permit
TR zinc	62.5 #/day	monthly avg	9.5
TR zinc	76	daily max	19
TR cadmium	.3	mon avg	.12
TR cadmium	.4	daily max	.24

000024

5/26/94 con't HVC

Chronology of Events

5/18/90 CDH issues NOV, C/D for violations of TR lead, silver & TSS (Dec. 89 & Jan-Feb 90)

5/21/90 RDC notified of CDH of Blaine discharge

10/19/90 RDC tells CDH of concrete dam in Blaine to route flow to St. Louis

10/26/90 CDH report of inspection 11/6/90. Need to cap geothermal spring in Pond 5.

6/5/91 CDH sends RDC letter about need to report WET tests

6/12/91 CDH tells RDC WQCD will seek civil penalty.

7/25/91 SAIC, for EPA, conducts Compliance Sampling Inspection. RDC tells SAIC that TRE is in progress.

8/20/91 CDH letter to RDC about 1st Quarter 91 WET failure.

8/29/91 RDC letter to CDH - TRE in progress

9/19/91 CDH stands behind 5/18/90 NOV.

10/17/91 RDH - TRE in progress.

11/18/91 CWQC Commission amends permits

12/27/91 CDH letter to RDC about CWQCC changes. Asks RDC to get toxicity under control.

2/19/92 CDH receives 2/9/91 WET testing.

3/11/92 RDC lab calls CDH - TRE not yet initiated.

6/23/92 CDH required RDC response to penalty offer.

6/26/92 No TRE results received by CDH.

Dec 28, 1993 - Toxicity Test Results by Camp Dresser & McGee - WET test passed

Nov. 12, 1993 - " " " " Ceriodaphnia d. failed, minnows passed

April 7, 1993 " " " " passed

Dec. 30, 1992 " " " " C. failed, minnows passed.

			Violations	Permitted
3/22/94 CDH letter from Kathleen L. Kalaman to RDC				
TR Silver #/day	30 day avg	~~[illegible]~~ .0113	.0081	
	daily max	~~[illegible]~~ .022	.016	
TR lead mg/l		.014	.009	
		.02	.018	
2/7/94 CDH letter as above:				
TR lead		<.013	.009	
		.02	.018	
12/3/93				
TSS mg/l		24 / 38	20 / 30	
TR zinc #/day	30 day avg.	11.8	9.5	

000025

5/26/94 cont MVC

10/18/93 TR silver #/day 30 day avg .1349 .0081
daily max .2452 .016

... plus WET test failed for Ceriodaphnia

9/20/93

6/93	zinc (mg/l)	30 day avg	62.5	9.5
7/93			15.8	9.5

1100 Back in office...

Called Kathleen L. Kalamen 692-3603

R-A is under increased scrutiny right now to try to get them to clean up discharge. Cannot locate officer of RDC. Doesn't know about new owners.

Received FWS T/E list.

1200 Called Nancy McGarigal in Durango F.S.

Mike Theile Realty in Telluride (303) 728-5440 represents

Azure Inc, Ollie Swanky out of Phoenix 602 953 6525

Called Theile & left message - need to find out how much property & when sold.

5/26/94 MVC

000026

5/27/94 Michael V. Carr

Called Theile back

- closed in April of 1994.
- not sure how much property was in transaction
- probably real estate development
- retained Walsh & Assoc. to do an evaluation including any necessary sampling.

Con't w/ typing draft, PA Worksheet.

5/27/94 MVC

000027

5/31/94 Michael V. Carr

Received BOR sampling data

Called Mike Tucker (303) 243-2778 at FWS about game fishing -

He said to call Dave Harper - CDOW in Dove Creek 677-2750

Called Dave Harper - left message.

Called Ruth Carlson - CDOW Durango 247-0855

She didn't think there were much fish in upper Dolores because of too much water during spring runoff & too little water during rest of year

She looked up a fishery biologist book -

1982 - fish sampling from two 500' reaches near Spruce & Burnett Creeks ≈ 2.5 miles below Rico.

- 2 rainbow ≈ 10 inches

1982 - lower reach

- 1 12" rainbow & 1 small brown & sculpins (bottom dwellers)

1982 - both reaches had improved habitat (instream boulders, check dams, etc.

1983 - increased browns 5-6", slightly more rainbow, brook

1984 - Greatly increased brown up to 10-12", probably moved in.

Called ~~Doc~~ MVC Walkers Fishing Hole in Denver 232-3474

Don't know how fishing is above McPhee. - Call Duranglers

Called Duranglers in Durango 385-4081

Locals do some fishing above McPhee, fish are big enough to keep & eat.

Gave text and Worksheet to Janet. She will give to Tim ASAP tomorrow. Gave John Rease the maps this AM - he will try to have them ready for Tim's ITR.

5/31/94 MVC

000028

6/3/94 Michael V. Carr

Addressed Tims ITR comments

Started PRFscore

- Two sources - Tailings, ponds, etc and mine drainage.
  - Used 1984 E&E leachate samples to characterize tailings source

SW4	SW10 (dupe)		
Arsenic	19	ug/l ppm	.019
Barium	40^{x}		.04
Beryllium	3.3^{x}		.0033
Cadmium	8.2		.0082
Chromium	11		.011
Cobalt	25^{x}		.025
Copper	83		.083
Iron	66 200		66.2
Lead	1140		1.14
Magnesium	43900		43.9
Manganese	14 400		14.4
Nickel 19^{x}	~~4~~		.019
Silver	9.9^{x}		.0099
Vanadium	6.7^{x}		.0067
Zinc	13 800		13.8

- Used BOR samples from mine drainage to characterize St. Louis Tunnel (28 T, 29 T, 48 T).

Arsenic	65 ug/l	(29T)	ppm .065
Copper	25	(28T, 29T)	.025
Iron	4,400	(29T)	4.4
Man	2,300	(29T)	2.3
Merc	.3	(28T, 29T)	.0003
Zinc	80	(28T, 29T)	.08

- Used 75 acres × 43,560 sq ft/Ac = 3,267,000 sq ft as source area
- Used 1 yd³ = 202 gallons × 1.5 MGD = 7426 yd³/Day for source area

000029

6/3/94 Con't MVC

- Assumed 1 pound of fish in fishery segment.
- Used BOR sed sample D-10, 25 miles downstream as hit (L II)
- " " sw D6T, 1 mile downstream. (L I for D.W.)
- " E&E sed sample SED-8, 1.5 miles downstream (L II)
- " " sw " SW-8 " " " (L II)

Score = 50.12

WhatIf #1 = Contaminated soil

Assumed L I concentration of ~~hits~~ to various metals in sources

" 2500 acres = 108,900,000 sq ft. (43560 sq ft/Ac)

" 123 people at L II Score = 53.23 = R-ASOIL.HPS

" 123 people at L I " = 70.79

WhatIf #2 wetlands

Rare communities ~~don~~ already have pathway score to 60 with surface water pathway maxed out at 100 from fishery.

Adding wetlands doesn't make any difference.

WhatIf #3 G.W. contamination

6 people is not enough of a target

6/3/94 Michael V Carr

CC0130

9/29/94 Michael V. Carr

Comments back from EPA (Pat Smith) on draft SIP document. Pat wants final on her desk by Oct. 11, that will be tight, will talk to her about an extension.

9/29/94 MVC

000031

9/30/94 Michael V. Cam

Spoke to Pat Smith.

- she has had contact with Walsh & Assoc who are PRPs contractor. They have done some sampling & have found hot spots in town. They assume tailings have been moved into town.
- she want doc. by Oct 11.
- she thinks site will need to become an ESI & will be NPL list.
- most of her comments hinge on tailings being moved into Rico.

9/30/94 MVC

000032

10/4/94 Michael V. Carr

Received T&E lists from DOW & F&W in June.
Lists are much the same as phone calls said.
Began addressing comments.
Went to Pats office & left note.
1405 Called Pat -
She said that Stan Powers (B. of Rec) in Durango has said that tailings were moved into Rico. This is in her Record of Communication that reopened the site.
Called Powers, he is gone for the day.

10/4/94 MVC

000033

10/5/94 Michael V. Carr
Continued with comments.
Called Powers
- they were in Rico approx 2 years ago as part of the water quality study when a resident approached them about street cover from tailing piles. B of R did not do any soil sampling.
- He said that tailings for cover appear to be coming from large tailings piles on hills to southeast of Silver Creek, east of Rico.
- He doesn't have any idea how much tailings has been removed or how much of Rico has been covered. No idea when procedure started but has probably been going on for years.

With the town of Rico as a source, all populations in distance rings need to be recalculated.

10/5/94 MVC

CCCL34

10/6/94 Michael V. Carr

Finished comments & turned doc into word processing
Tried to find Tech Pub #35 of Utah Water Rights and
USGS - they don't have it.
Talked to Luke Chavez about it - he said not
to worry about the publication, just reword
verbage so interconnection of aquifers is
clear.
Talked to John Reidinger (wrong laybock) in Durango Forest Service office.
Most mines were patented which now makes them
private property. However, there are many scattered,
pie-shaped chunks of public land (Forest) in the
private holdings.
Made final corrections & gave to Word processing.

10/6/94

000035

10/7/94 Michael V Cam

Document came out of word processing - Barb said she would review/edit it. But when I checked it I found several errors. Gave it back to Janet to fix.

10/7/94 MVC

000036

10/10/94 Michael Vs Cam

Final final out of word processing; looks good this time around. Will deliver to Pat Smith tomorrow.

10/10/94 MVC

000037

10/11/94 Michael V. Carr
Delivered copies of final document to Pat Smith

10/11/94 MVC

000038

10/17/94 Michael V. Carr

Received signature pages for final document from Pat Smith.

Pat also enclosed copies of letters to Bob Dent of ARCO and to Walsh & Assoc. detailing Rico assignment as ESI in the future.

10/17/94 MVC

GC0039

12/7/94 Michael V. Carr
Pat Smith called - close out files but hold on to them until ESI is assigned.

12/7/94 MVC

000040

1/16/95 Michael V. Carr

Worked on organizing & closing out files.

Gave files to Metha.

1/16/95 MVC

CCC160 ERB Files Andrea MacIntosh

CERCLIS FILES - LAI - Nancy 294-1195

RCRA FILES - Nick Robinson 293-1676

CDH

Glenn Mallory

CDH Files - Jo Chavez or Julie Rodriguez

WQCD - 692-3500 wellhead protection Kathleen Reilly 692-3573

CDOW Dave Weber 291-7231

WQCD - 692-3500 Pat Nelson

WQCC - 692-7525 Marla Beibershine

Files - Janet Fujita

EPA Wtr Management - NPDES branch 294-1382 - Debora Griffith

Colo. Natl Heritage Program - Katie Pague

Durango - Ruth Carlson 247-0855

~~Denver~~ Dove Creek - Dave Harper 677-2750

Colo. Dept. of Wildlife - Montrose - Bob Clark (303) 249-3431 fax 2557

Colo. Dept. of Natl Rscs - Dept. of Minerals & Geology

Carl Mount 866-3567 Office of Mines - Joe Nugent 880-2983

Jim Stevens - southern Colo.

BLM - Charles Fair (719) 275-0631 Montrose - District Groundwater Geologist Ben Sprouse (303) 249-7791

Denver Jim Yahnke 236-3778

B of Rec - Durango - Stan Powers (303) 385-6555

FIRM FEMA Maps

Colo. Dept. of Ntl Rscs - Water Conservation Board - Brian Hyde 866-3441 fax 4474

Colo. State Parks Natural Areas Inventory Janet Cole 866-3203 x 330

Durango Nancy McGarigal (303) 882-7296

US Forest Service - Dolores - John Raid... (303) 882-7296 ~~Durango~~

Fish wildlife - Lee Carlson - Denver

Grand Junction Mike Tucker/Terry Ireland 243-2778

CDOT - Durango - Ted Vickers

Anaconda - Bob Dent

COLORADO DEPARTMENT OF HEALTH
WATER QUALITY CONTROL COMMISSION

CLASSIFICATIONS AND NUMERIC STANDARDS FOR SAN JUAN RIVER AND DOLORES RIVER BASINS

3.4.0

STATE OF COLORADO

Colorado Department of Health
4300 Cherry Creek Drive So.
Denver, CO 80222-1530

Rec'd
May 23, 1994

WQCC 2001

EPA CLOSEOUT COPY

ADOPTED:	July 13, 1982
EFFECTIVE:	August 30, 1982
AMENDED:	December 6, 1982
EFFECTIVE:	January 30, 1983
AMENDED:	December 12, 1983
EFFECTIVE:	January 30, 1984
AMENDED:	December 6, 1985
EFFECTIVE:	January 30, 1986
AMENDED:	April 7, 1986
EFFECTIVE:	May 30, 1986
AMENDED:	November 7, 1989
EFFECTIVE:	December 31, 1989
EMERGENCY AMENDMENT:	February 5, 1990
AMENDED:	June 5, 1990
EFFECTIVE:	July 31, 1990
AMENDED:	January 6, 1992
EFFECTIVE:	March 1, 1992
AMENDED:	March 1, 1993
EFFECTIVE:	April 30, 1993
AMENDED:	September 7, 1993
EFFECTIVE:	October 30, 1993

STATE OF COLORADO

WATER QUALITY CONTROL COMMISSION
''QCC-CC-B2
-300 Cherry Creek Drive South
Denver, Colorado 80222-1530
Phone: (303) 692-3520

Roy Romer
Governor
Patricia A. Nolan, MD, MPH
Executive Director

NOTICE OF FINAL ADOPTION

PURSUANT to the provisions of sections 24-4-103(5) and 24-4-103(11), C.R.S.

NOTICE IS HEREBY GIVEN that the Colorado Water Quality Control Commission, after a public hearing on September 7, 1993, and complying with the provisions of 24-4-103(3), (4) and 25-8-401(1), C.R.S., amended on September 7, 1993, pursuant to 25-8-202(1)(a), (b), and (2); 25-8-203; and 25-8-204, C.R.S., and Section 2.1.3 of the "Procedural Rules" the regulation entitled:

> "Classifications and Numeric Standards for San Juan and Dolores River Basins", 3.4.0 (5 CCR 1002-8)

Providing for amendment for the water quality standard for selenium and to correct a typographical error on the silver Trout equation.

Also, pursuant to 24-4-103(8)(b), C.R.S., this amendment was submitted to the Attorney General for review and was found to be within the authority of the Water Quality Control Commission to promulgate, and further that there are no apparent constitutional deficiencies in its form or substance. Furthermore, in adopting this amendment the Commission also adopted a general Statement of Basis, Specific Statutory Authority, and Purpose in compliance with 24-4-103(4), C.R.S.

This amendment will be submitted to the Office of Legislative Legal Services within twenty (20) days after the date of the Attorney General's Opinion, pursuant to 24-4-103(8)(d), C.R.S., and to the Secretary of State in time for October 10, 1993 publication in the Colorado Register pursuant to 24-4-103(5) and (11)(d), C.R.S., and will become effective October 30, 1993.

A copy of the amended regulation is attached and made a part of this notice.*

Dated this 27th day of September, 1993, at Denver, Colorado.

WATER QUALITY CONTROL COMMISSION

Marla L. Biberstine

Marla L. Biberstine, Staff Assistant

*A copy of this regulation
is available at a charge of $5.00
pursuant to 24-4-103(9), C.R.S.

se93.fa

3.4.0 CLASSIFICATIONS AND NUMERIC STANDARDS

SAN JUAN RIVER AND DOLORES RIVER BASINS

3.4.1 AUTHORITY

These Regulations are promulgated pursuant to C.R.S. 1973, 25-8-101 et seq., as amended, and in particular, 25-8-203 and 25-8-204.

3.4.2 PURPOSE

These regulations establish classifications and numeric standards for the San Juan and the Dolores River Basins, including all tributaries and standing bodies of water south of the northern Dolores County lines, as indicated in Section 3.4.6. The classifications identify the actual beneficial uses of the water. The numeric standards are assigned to determine the allowable concentrations of various parameters. Discharge permits will be issued by the Water Quality Control Division to comply with basic, narrative, and numeric standards and control regulations so that all discharges to waters of the State protect the classified uses. (See Section 3.1.14). It is intended that these and all other stream classifications and numeric standards be used in conjunction with and be an integral part of Regulation 3.1.0 - REGULATIONS ESTABLISHING BASIC STANDARDS AND AN ANTIDEGRADATION STANDARD AND ESTABLISHING A SYSTEM FOR CLASSIFYING STATE WATERS, AND ASSIGNING STANDARDS, AND FOR GRANTING TEMPORARY MODIFICATIONS.

3.4.3 INTRODUCTION

These Regulations and Tables present the classifications and numeric standards assigned to stream segments listed in the attached Tables (See Section 3.4.7). As additional stream segments are classified and numeric standards for designated parameters are assigned for this drainage system, they will be added to or replace the numeric standards in the Tables in Section 3.4.7. Any additions or revisions of classifications or numeric standards can be accomplished only after public hearing by the Commission and proper consideration of evidence and testimony as specified by the statute and the "basic regulations".

3.4.4 DEFINITIONS

See the Colorado Water Quality Control Act and the codified water quality regulations for definitions.

3.4.5 BASIC STANDARDS

(1) All waters of the San Juan/Dolores River Basin are subject to the following standard for temperature. (Discharges regulated by permits, which are within the permit limitations, shall not be subject to enforcement proceedings under this standard). Temperature shall maintain a normal pattern of diurnal and seasonal fluctuations with no abrupt changes and shall have no increase in temperature of a magnitude, rate, and duration deemed deleterious to the resident aquatic life. Generally, a maximum 3°C increase over a minimum of a four-hour period, lasting 13 hours maximum, is deemed acceptable for discharges fluctuating in volume or temperature. Where temperature increases cannot be maintained within this range using Best Management Practices (BMP), Best Available Technology Economically Achievable (BATEA), and Best Practical Waste Treatment Technology (BPWTT) control measures, the Commission may determine by a rulemaking hearing in accordance with the requirements of the applicable statutes and the basic regulations, whether or not a change in classification is warranted.

(2) See Basic Standards and Methodologies for Surface Water, 3.1.11 for a listing of organic standards. The column in the tables headed "Water Fish" are presumptively applied to all aquatic life class 1 streams and are applied to aquatic life class 2 streams on a case-by-case basis as shown in the tables in 3.4.6.

(3) URANIUM

(a) All waters of the San Juan/Dolores River Basin, are subject to the following basic standard for uranium, unless otherwise specified by a water quality standard applicable to a particular segment. However, discharges of uranium regulated by permits which are within these permit limitations shall not be a basis for enforcement proceedings under this basic standard.

(b) Uranium level in surface waters shall be maintained at the lowest practicable level.

(c) In no case shall uranium levels in waters assigned a water supply classification be increased by any cause attributable to municipal, industrial, or agricultural discharges so as to exceed 40 pCi/l or naturally-occurring concentrations (as determined by the State of Colorado), whichever is greater.

(d) In no case shall uranium levels in waters assigned a water supply classification be increased by a cause attributable to municipal, industrial, or agricultural discharges so as to exceed 40 pCi/l where naturally-occurring concentrations are less than 40 pCi/l.

3.4.6 TABLES

(1) Introduction

The numeric standards for various parameters in the attached tables were assigned by the Commission after a careful analysis of the data presented on actual stream conditions and on actual and potential water uses.

Numeric standards are not assigned for all parameters listed in the Tables attached to 3.1.0. If additional numeric standards are found to be needed during future periodic reviews, they can be assigned by following the proper hearing procedures.

(2) Abbreviations:

The following abbreviations are used in the attached tables:

ac	=	acute (1-day)
Ag	=	silver
Al	=	aluminum
As	=	arsenic
B	=	boron
Ba	=	barium
Be	=	beryllium
Cd	=	cadmium
ch	=	chronic (30-day)
Cl	=	chloride
Cl_2	=	residual chlorine
CN	=	free cyanide

CrIII	=	trivalent chromium
CrVI	=	hexavalent chromium
Cu	=	copper
dis	=	dissolved
D.O.	=	dissolved oxygen
F	=	fluoride
F.Coli	=	fecal coliforms
Fe	=	iron
Hg	=	mercury
mg/l	=	milligrams per liter
ml	=	milliliters
Mn	=	manganese
NH_3	=	un-ionized ammonia as N(nitrogen)
Ni	=	nickel
NO_2	=	nitrite as N (nitrogen)
NO_3	=	nitrate as N (nitrogen)
OW	=	outstanding waters
P	=	phosphorus
Pb	=	lead
S	=	sulfide as undissociated H_2S (hydrogen sulfide)
Se	=	selenium
SO_4	=	sulfate
sp	=	spawning
Tl	=	thallium
tr	=	trout
Trec	=	total recoverable
TVS	=	table value standard
U	=	uranium

ug/l	=	micrograms per liter
UP	=	use-protected
Zn	=	zinc

(3) Table Value Standards

In certain instances in the attached tables, the designation "TVS" is used to indicate that for a particular parameter a "table value standard" has been adopted. This designation refers to numerical criteria set forth in the Basic Standards and Methodologies for Surface Water. The criteria for which the TVS are applicable are on the following table.

TABLE VALUE STANDARDS

(Concentrations in ug/l unless noted)

PARAMETER[1]	TABLE VALUE STANDARDS [2][3]
Ammonia	Cold Water Acute = 0.43/FT/FPH/2[4] in mg/l Warm Water Acute = 0.62/FT/FPH/2[4] in mg/l
Cadmium	Acute = $e^{(1.128[\ln(hardness)]-2.905)}$ Chronic = $e^{(0.7852[\ln(hardness)]-3.490)}$ *(Trout) = $e^{(1.128[\ln(hardness)]-3.828)}$
Chromium III	Acute = $e^{(0.819[\ln(hardness)]+3.688)}$ Chronic = $e^{(0.819[\ln(hardness)]+1.561)}$
Chromium VI	Acute = 16 Chronic = 11
Copper	Acute = $e^{(0.9422[\ln(hardness)]-1.4634)}$ Chronic = $e^{(0.8545[\ln(hardness)]-1.465)}$
Lead	Acute = $e^{(1.6148[\ln(hardness)] - 2.8736)}$ Chronic = $e^{(1.417[\ln(hardness)] - 5.167)}$
Nickel	Acute = $e^{(0.76[\ln(hardness)]+3.33)}$ Chronic = $e^{(0.76[\ln(hardness)]+1.06)}$
Selenium	Acute = 135 Chronic = 17
Silver	Acute = $e^{(1.72[\ln(hardness)]-7.21)}$ Chronic = $e^{(1.72[\ln(hardness)]-9.06)}$ *(Trout) = $e^{(1.72[\ln(hardness)]-10.51)}$
Uranium	Acute = $e^{(1.102[\ln(hardness)]+2.7088)}$ Chronic = $e^{(1.102[\ln(hardness)]+2.2382)}$

TABLE VALUE STANDARDS
(Concentrations in ug/l unless noted)

PARAMETER[1]	TABLE VALUE STANDARDS [2][3]
Zinc	Acute = $e^{(0.8473[\ln(hardness)]+0.8604)}$ Chronic = $e^{(0.8473[\ln(hardness)]+0.7614)}$

TABLE VALUE STANDARDS - FOOTNOTES

(1) Metals are stated as dissolved unless otherwise specified.

(2) Hardness values to be used in equations are in mg/l as calcium carbonate. The hardness values used in calculating the appropriate metal standard should be based on the lower 95 per cent confidence limit of the mean hardness value at the periodic low flow criteria as determined from a regression analysis of site-specific data. Where insufficient site-specific data exists to define the mean hardness value at the periodic low flow criteria, representative regional data shall be used to perform the regression analysis. Where a regression analysis is not appropriate, a site-specific method should be used. In calculating a hardness value, regression analyses should not be extrapolated past the point that data exist.

(3) Both acute and chronic numbers adopted as stream standards are levels not to be exceeded more than once every three years on the average.

(4) $FT = 10^{.03(20-TCAP)}$;
<u>TCAP</u> less than or equal to <u>T</u> less than or equal to <u>30</u>

$FT = 10^{.03(20-T)}$;
<u>0</u> less or equal to <u>T</u> less than or equal to <u>TCAP</u>

TCAP = 20° C cold water aquatic life species present

TCAP = 25° C cold water aquatic life species absent

FPH = 1; <u>8</u> less than <u>pH</u> less than or equal to <u>9</u>

$FPH = \frac{1 + 10^{(7.4-pH)}}{1.25}$; 6.5 less than or equal to <u>pH</u> less than or equal to <u>8</u>

FPH means the acute pH adjustment factor; defined by the above formulas.

FT Means the acute temperature adjustment factor, defined by the above formulas.

T means temperature measured in degrees celsius.

TCAP means temperature CAP; the maximum temperature which affects the toxicity of ammonia to salmonid and non-salmonid fish groups.

NOTE: If the calculated acute value is less than the calculated chronic value, then the calculated chronic value shall be used as the acute standard.

STREAM CLASSIFICATIONS and WATER QUALITY STANDARDS

REGION: 9 BASIN: SAN JUAN RIVER Stream Segment Description	Desig	Classifications	NUMERIC STANDARDS PHYSICAL and BIOLOGICAL	INORGANIC mg/l		METALS ug/l			TEMPORARY MODIFICATIONS AND QUALIFIERS
1. Mainstem of the Navajo River and the Little Navajo River, including all tributaries, lakes and reservoirs, from the boundary of the South San Juan Wilderness Area to the San Juan-Chama diversion.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
2. Mainstem of the Navajo River from the San Juan-Chama diversion to the Colorado/New Mexico border near Edith, Colorado and from the Colorado/New Mexico border tothe confluence with the San Juan River.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ch)=50 Cd(ch)=.4 CrIII(ch)=50 CrVI(ch)=25 Cu(ch)=14	Fe(ch)=300(dis) Fe(ch)=1200 Pb(ch)=5 Mn(ch)=50(dis) Mn(ch)=1000	Hg(ch)=.05 Ni(ch)=50 Se(ch)=10 Ag(ch)=.1 Zn(ch)=50	All metals are Trec unless otherwise noted.
3. Mainstem of the Little Navajo River from the San Juan-Chama diversion to the confluence with the Navajo River; all tributaries to the Navajo River and the Little Navajo River, including all lakes and Reservoirs, from the San Juan-Chama diversions to the confluence with the San Juan River.	UP	Aq Life Warm 2 Recreation 2 Agriculture	D.O. = 5.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml						
4. All tributaries to the San Juan River, Rio Blanco, and Navajo River including all lakes and reservoirs, which are within the Weminuche Wilderness area and South San Juan Wilderness Area.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
5. Mainstem of the San Juan River and the East Fork and West Fork of the San Juan River, from the boundary of the Weminuche Wilderness Area (West Fork) and the source (East Fork) to the confluence with Fourmile Creek, including all tributaries, lakes and reservoirs except for tributaries, lakes, and reservoirs included in Segment 4.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
6. Mainstem of the San Juan River from the confluence with Fourmile Creek to Navajo Reservoir.		Aq Life Cold 1 Recreation 1 Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=100	As(ch)=50 Cd(ch)=.4 CrIII(ch)=100 CrVI(ch)=25 Cu(ch)=20	Fe(ch)=2400 Pb(ch)=10 Mn(ch)=1000 Hg(ch)=50 Ni(ch)=50	Se(ch)=20 Ag(ch)=.1 Zn(ch)=50	All metals are Trec unless otherwise noted.
7. Navajo Reservoir (portion in Colorado.		Aq Life Warm 1 Recreation 1 Water Supply Agriculture	D.O. = 5.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.5 NO_3=10 Cl=250 SO_4=250	As(ch)=50 Cd(ch)=.4 CrIII(ch)=50 CrVI(ch)=25 Cu(ch)=5	Fe(ch)=300(dis) Fe(ch)=1000 Pb(ch)=4 Mn(ch)=50(dis) Mn(ch)=1000	Hg(ch)=.05 Ni(ch)=50 Se(ch)=10 Ag(ch)=.1 Zn(ch)=50	All metals are Trec unless otherwise noted.
9. Mainstem of the Rio Blanco, including all tributaries, lakes, and reservoirs, from the boundary of South San Juan Wilderness Area to the confluence with the San Juan River, except for the specific listing in Segment 10.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch).01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
10. Mainstem of the Rito Blanco River from Echo Ditch to the confluence with the Rio Blanco River.	UP	Aq Life Cold 2 Recreation 2 Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml						

STREAM CLASSIFICATIONS and WATER QUALITY STANDARDS

REGION: 9 BASIN: SAN JUAN RIVER Stream Segment Description	Desig	Classifications	NUMERIC STANDARDS						TEMPORARY MODIFICATIONS AND QUALIFIERS
			PHYSICAL and BIOLOGICAL	INORGANIC mg/l		METALS ug/l			
11. All tributaries to the San Juan River in Archuleta County, including all lakes and reservoirs, except for specific listings in Segments 1, 4, 5, and 9.	UP	Aq Life Warm 2 Recreation 2 Agriculture	D.O. = 5.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml						

STREAM CLASSIFICATIONS and WATER QUALITY STANDARDS

REGION: 9 BASIN: PIEDRA RIVER Stream Segment Description	Desig	Classifications	NUMERIC STANDARDS PHYSICAL and BIOLOGICAL	INORGANIC mg/l		METALS ug/l			TEMPORARY MODIFICATIONS AND QUALIFIERS
1. All tributaries to the Piedra River, including all lakes and reservoirs, which are within the Weminuche Wilderness Area.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
2. Mainstem of the Piedra River, including the East and Middle Forks, from the boundary of the Weminuche Wilderness Area to the confluence with Indian Creek, except for the specific listing in Segment 3.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
3. Mainstem of the East Fork of the Piedra River from the Piedra Falls Ditch to the confluence with Pagosa Creek.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O.(sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
4. Mainstem of the Piedra River from the confluence with Indian Creek to Navajo Reservoir.		Aq Life Cold 1 Recreation 1 Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=100	As(ch)=50 Cd(ch)=.4 CrIII(ch)=100 CrVI(ch)=25 Cu(ch)=16	Fe(ch)=1500 Pb(ch)=4 Mn(ch)=1000 Hg(ch)=.05 Ni(ch)=50	Se(ch)=20 Ag(ch)=.1 Zn(ch)=50	All metals are Trec unless otherwise noted.
5. All tributaries to the Piedra River, including all lakes and reservoirs, from the boundary of the Weminuche Wilderness Area to a point immediately below the confluence with Devil Creek.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
6. All tributaries to the Piedra River, including all lakes and reservoirs, from a point immediately below the confluence with Devil Creek to Navajo Reservoir, except for the specific listings in Segment 7.	UP	Aq Life Warm 2 Recreation 2 Agriculture	D.O. = 5.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml						
7. "Hatcher Lake, Stevens Lake, Pagosa Lake, Village Lake and Forest Lake."	UP	Aq Life Warm 1 Recreation 2 Water Supply Agriculture	D.O. = 5.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml	NH_3(ac)=TVS NH_3(ch)=0.06 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.25 NO_2=0.5 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac/ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac/ch)=TVS Zn(ac/ch)=TVS	

STREAM CLASSIFICATIONS and WATER QUALITY STANDARDS

REGION: 9 BASIN: LOS PINOS RIVER Stream Segment Description	Desig	Classifications	NUMERIC STANDARDS PHYSICAL and BIOLOGICAL	INORGANIC mg/l		METALS ug/l			TEMPORARY MODIFICATIONS AND QUALIFIERS
1. All tributaries to the Los Pinos River, including all lakes and reservoirs, which are within the Weminuche Wilderness Area.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
2a. Mainstem of the Los Pinos River from the boundary of the Weminuche Wilderness Area to the U.S. Hwy 160 except for the specific listing in Segment 3.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
2b. Mainstem of the Los Pinos River from U.S. Hwy 160 to the Colorado/New Mexico border.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
3. Vallecito Reservoir.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
4. All tributaries to the Los Pinos River and Vallecito Reservoir, including all lakes and reservoirs, from the boundary of the Weminuche Wilderness Area to a point immediately below the confluence with Bear Creek (T35N, R7W), except for the specific listing in Segment 5; mainstems of Beaver Creek, Ute Cr Creek, Ute Creek, and Spring Creek from their sources to their confluences with the Los Pinos River.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
5. Mainstem of Vallecito Creek from the boundary of the Weminuche Wilderness Area to Vallecito Reservoir.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=1 CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
6. All tributaries to the Los Pinos River, including all lakes and reservoirs, from a point immediately below the confluence with Bear Creek (T35N, R7W) to the Colorado/New Mexico border, except for the specific listing in Segment 4; all tributaries to the San Juan River in La Plata County.	UP	Aq Life Cold 2 Recreation 2 Agriculture	D.O. = 6.0 mg/l D.O.(sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml						

STREAM CLASSIFICATIONS and WATER QUALITY STANDARDS

REGION: 9 BASIN: ANIMAS AND FLORIDA RIVER Stream Segment Description	Desig	Classifications	NUMERIC STANDARDS PHYSICAL and BIOLOGICAL	INORGANIC mg/l		METALS ug/l			TEMPORARY MODIFICATIONS AND QUALIFIERS
1. All tributaries to the Animas River and Florida River, including all lakes and reservoirs, which are within the Weminuche Wilderness Area.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.5 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
2. Mainstem of the Animas River, including all tributaries, from the source to a point immediately above the confluence with Elk Creek, except for specific listings in Segments 1 and 5 through 8a and 8b.		Recreation 2	pH = 6.5-9.0 F.Coli=2000/100ml						
3. Mainstem of the Animas River from a point immediately above the confluence with Elk Creek to the confluence with Junction Creek.	UP	Aq Life Cold 1 Recreation [illegible] Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=[illegible]/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=[illegible]	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ch)=50 Cd(ch)=.6 CrIII(ch)=[illegible] CrVI(ch)=[illegible] Cu(ch)=[illegible]	Fe(ch)=300(dis) Fe(ch)=1150 Pb(ch)=43 Mn(ch)=50(dis) Mn(ch)=1000	Hg(ch)=.05 Ni(ch)=50 Se(ch)=10 Ag(ch)=.1 Zn(ch)=470	All metals are Trec unless otherwise noted.
4. Mainstem of the Animas River from the confluence with Junction Creek to the Colorado/New Mexico border.	UP	Aq Life Cold 1 Recreation [illegible] Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=[illegible]/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=[illegible]	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ch)=[illegible] Cd(ch)=1 CrIII(ch)=[illegible] CrVI(ch)=[illegible] Cu(ch)=20	Fe(ch)=300(dis) Fe(ch)=1500 Pb(ch)=55 Mn(ch)=50(dis) Mn(ch)=1000	Hg(ch)=.05 Ni(ch)=100 Se(ch)=10 Ag(ch)=.1 Zn(ch)=150	All metals are Trec unless otherwise noted.
5. Mainstem, including all tributaries, lakes and reservoirs, of Cinnamon Creek, Grouse Creek, Picayne Gulch, Minnie Gulch, Maggie Gulch, Cunningham Creek, Boulder Creek, Whitehead Gulch, and Molas Creek from their sources to their confluences with the Animas River.		Aq Life Cold 1 Recreation 2 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
6. Mainstem of Cement Creek, including all tributaries, lakes, and reservoirs, from the source to the confluence with the Animas River.		Recreation 2	pH = 6.5-9.0 F.Coli=2000/100ml						
7. Mainstem of Mineral Creek, including all tributaries, from the source to a point immediately above the confluence with South Mineral Creek except for the specific listing in Segment 8a.		Recreation 2 Agriculture	pH = 3.5-9.0 F.Coli=2000/100ml	CN=0.2	B=0.75	As(ch)=0.1 Cd(ch)=0.005 CrIII(ch)=0.1 CrVI(ch)=0.1	Cu(ch)=0.2 Pb(ch)=0.035 Hg(ch)=0.05 Ni(ch)=0.05	Se(ch)=0.02 Ag(ch)=0.1 Zn(ch)=2.0	All metals are Trec unless otherwise noted.
8a. Mainstem of South Mineral Creek including all tributaries, lakes and reservoirs from the source to a point immediately above the confluence with Clear Creek; mainstems, including all tributaries, lakes and reservoirs of Mill Creek, and Bear Creek from sources to confluence with Mineral Creek; all lakes and reservoirs in the drainage areas described in Segments 7 through 9.		Aq Life Cold 1 Recreation 2 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
8b. Mainstem of South Mineral Creek, including all tributaries, from a point immediately above the confluence with Clear Creek to the confluence with Mineral Creek and the mainstem of Mineral Creek from immediately above the confluence with the South Fork to the confluence with the Animas River.		Aq Life Cold 1 Recreation 2 Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05	As(ch)=50 Cd(ch)=2 CrIII(ch)=100 CrVI(ch)=25 Cu(ch)=5	Fe(ch)=1000 Pb(ch)=14 Mn(ch)=1000 Hg(ch)=.05 Ni(ch)=50	Se(ch)=20 Ag(ch)=.1 Zn(ch)=50	All metals are Trec unless otherwise noted.

STREAM CLASSIFICATIONS and WATER QUALITY STANDARDS

REGION: 9 BASIN: ANIMAS AND FLORIDA RIVER Stream Segment Description	Desig	Classifications	NUMERIC STANDARDS PHYSICAL and BIOLOGICAL	INORGANIC mg/l		METALS ug/l			TEMPORARY MODIFICATIONS AND QUALIFIERS
9. Mainstem of Clear Creek from the source to the confluence with South Mineral Creek.	UP	Aq Life Cold 1 Recreation 2 Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05	As(ch)=50 Cd(ch)=.4 CrIII(ch)=100 CrVI(ch)=25 Cu(ch)=150	Fe(ch)=5000 Pb(ch)=4 Mn(ch)=1000 Hg(ch)=.05 Ni(ch)=50	Se(ch)=20 Ag(ch)=.1 Zn(ch)=480	All metals are Trec unless otherwise noted
10. Mainstem of the Florida River from the boundary of the Weminuche Wilderness Area to the Florida Farmers Canal Headgate, except for the specific listings in Segment 12b.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O.=6.0 mg/l D.O.= 7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/cu)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
11. Mainstem of the Florida River from the Florida Farmers Canal Headgate to the confluence with the Animas River.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O.(sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
12a. All tributaries to the Animas River, including all lakes and reservoirs from a point immediately above the confluence with Elk Cr. to a point immediately below the confluence with Hermosa Cr. except for specific listings in Segment 15. All tributaries to the Florida River including all lakes and reservoirs from the source to the outlet of Lemon Reservoir except the specific listing in Segment 1. Mainstems of Red and Shearer Creeks from their sources to their confluences with the Florida River.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=[illegible]/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=[illegible]	S=[illegible] B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
12b. Lemon Reservoir.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10.02 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
13a. Mainstem of Junction Creek, and including all tributaries, from U.S. Forest Boundary to confluence with Animas River.	UP	Aq Life Cold 2 Recreation 2 Agriculture	D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05	As(ac/ch)=TVS Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac/ch)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec) Ni(ac/ch)=TVS Se(ac/ch)=TVS	Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
13b. All tributaries to the Animas River, including all lakes and reservoirs, from a point immediately below the confluence with Hermosa Creek to the Colorado/New Mexico border, except for the specific listings in Segments 10, 11, 12a, 12b, 13a and 14; all tributaries to the Florida River, including all lakes and reservoirs, from the outlet of Lemon Reservoir to the confluence with the Animas River, except for specific listings in Segment 12a.	UP	Aq Life Cold 2 Recreation 2 Agriculture	D.O. = 6.0 mg/l D.O.(sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml						

STREAM CLASSIFICATIONS and WATER QUALITY STANDARDS

REGION: 9 BASIN: ANIMAS AND FLORIDA RIVER Stream Segment Description	Desig	Classifications	NUMERIC STANDARDS PHYSICAL and BIOLOGICAL	INORGANIC mg/l		METALS ug/l			TEMPORARY MODIFICATIONS AND QUALIFIERS
14. Mainstem of Lightner Creek from the source to the confluence with the Animas River.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS MN(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
15. Mainstem of Purgatory Creek from source to Cascade, Cascade Creek, Soulding Creek from the source to Elbert Cree, and Nary Draw from the source to Naviland Lake.	UP	Aq Life Cold 2 Recreation 2 Water Supply Agriculture	D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml	CN=0.2 S=0.05 NO_2=1.0	NO_3=10 Cl=250 SO_4=250	As(ch)=50 Cd(ch)=10 CrIII(ch)=50 CrVI(ch)=50	Cu(ch)=1000 Fe(ch)=0.3(dis) Pb(ch)=50 Mn(ch)=50	Hg(ch)=2 Se(ch)=10 Ag(ch)=50 Zn(ch)=5000	All metals are Trec unless otherwise noted.

STREAM CLASSIFICATIONS and WATER QUALITY STANDARDS

REGION: 9 BASIN: LA PLATA RIVER, MANCOS RIVER, McELMO CREEK, AND SAN JUAN RIVER IN MONTEZUMA COUNTY AND DOLORES COUNTY Stream Segment Description	Desig	Classifications	NUMERIC STANDARDS PHYSICAL and BIOLOGICAL	INORGANIC mg/l		METALS ug/l			TEMPORARY MODIFICATIONS AND QUALIFIERS
1. Mainstem of the La Plata River, including all tributaries, lakes, and reservoirs, from the source to the Hay Gulch diversion south of Hesperus.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
2. Mainstem of the La Plata River from the Hay Gulch diversion south of Hesperus to the Colorado/New Mexico border.	UP	Aq Life Warm 2 Recreation 2 Agriculture	D.O.=5.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml	NH_3(ac)=TVS NH_3(ch)=0.1 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05	As(ch)=50 Cd(ch)=.1 CrIII(ch)=100 CrVI(ch)=25 Cu(cu)=10	Fe(ch)=1000 Pb(ch)=43 Mn(ch)=1000 Hg(ch)=.05 Ni(ch)=100	Se(ch)=20 Ag(ch)=.1 Zn(ch)=140	All metals are Trec unless otherwise noted.
3. All tributaries to the La Plata River, including all lakes and reservoirs, from the Hay Gulch diversions south of Hesperus to the Colorado/New Mexico border.	UP	Aq Life Warm 2 Recreation 2 Agriculture	D.O. = 5.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml						
4. Mainstem of the Mancos River, including all tributaries, lakes, and reservoirs, from the source of the East, West and Middle Forks to Hwy 160.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
5. Mainstem of the Mancos River from Hwy 160 to the Colorado/New Mexico border.	UP	Aq Life Warm 2 Recreation 2 Agriculture	D.O. = 5.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml	NH_3(ac)=TVS NH_3(ch)=0.01 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05	As(ch)=50 Cd(ch)=1 CrIII(ch)=100 CrVI(ch)=25 Cu(ch)=30	Fe(ch)=5100 Pb(ch)=25 Mn(ch)=1000 Hg(ch)=.05 Ni(ch)=100	Se(ch)=20 Ag(ch)=.1 Zn(ch)=150	All metals are Trec unless otherwise noted.
6. All tributaries to the Mancos River, including all lakes and reservoirs, from Hwy 160 to the Colorado/New Mexico border.	UP	Aq Life Warm 2 Recreation 2 Agriculture	D.O.=5.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml						
7. Mainstem of McElmo Creek from the source to the Colorado/Utah border.	UP	Aq Life Warm 2 Recreation 2 Agriculture	D.O. = 5.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml	NH_3(ac)=TVS NH_3(ch)=0.1 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05	As(ch)=50 Cd(ch)=5 CrIII(ch)=100 CrVI(ch)=25 Cu(ch)=19	Fe(ch)=10400 Pb(ch)=50 Mn(ch)=1000 Hg(ch)=.05 Ni(ch)=200	Se(ch)=20 Ag(ch)=.15 Zn(ch)=100	All metals are Trec unless otherwise noted.
8. All tributaries to McElmo Creek and the San Juan River in Montezuma and Dolores Counties, including all lakes and reservoirs, except for specific listings in Segments 2 through 7.	UP	Aq Life Warm 2 Recreation 2 Agriculture	D.O. = 5.0 mg/l pH=6.5-9.0 F.Coli=2000/100 ml						
9. Mainstem of the San Juan River in Montezuma County.		Aq Life Warm 1 Recreation 1 Agriculture	D.O. = 5.0 mg.1 pH=6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.06 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.5	As(ac/ch)=TVS Cd(ac/ch)=TVS CrIII(ac/ch)=TVS CrVI(ac/ch)=TVS	Cu(ac/ch)=TVS Fe(ch)=2200(Trec) Pb)ac/ch)=TVS Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Se(ac/ch)=TVS Ag(ac/ch)=TVS Zn(ac/ch)=TVS	

STREAM CLASSIFICATIONS and WATER QUALITY STANDARDS

REGION: 9 BASIN: DOLORES RIVER Stream Segment Description	Desig	Classifications	NUMERIC STANDARDS PHYSICAL and BIOLOGICAL	INORGANIC mg/l		METALS ug/l			TEMPORARY MODIFICATIONS AND QUALIFIERS
1. All tributaries to the Dolores River and West Dolores River, including all tributaries, lakes, and reservoirs, which are within the Lizard Head Wilderness.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH$_3$(ac)=TVS NH$_3$(ch)=0.02 Cl$_2$(ac)=0.019 Cl$_2$(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO$_2$=0.05 NO$_3$=10 Cl=250 SO$_4$=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS MN(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
2. Mainstem of the Dolores River from the source to a point immediately above the confluence with Horse Creek.		Aq Life Cold 1 Recreation 2 Water Supply Agriculture	D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml	NH$_3$(ac)=TVS $_3$(ch)=0.02 Cl$_2$(ac)=0.019 Cl$_2$(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO$_2$=0.05 NO$_3$=10 Cl=250 SO$_4$=250	As(ch=50 Cd(ch)=.4 CrIII(ch)=50 CrVI(ch)=25 Cu(ch)=6	Fe(ch)=1000 Pb(ch)=4 Mn(ch)=50(dis) Mn(ch)=1000 Hg(ch)=.05	Ni(ch)=50 Se(ch)=10 Ag(ch)=.1 Zn(ch)=100	All metals are Trec unless otherwise noted.
3. Mainstem of the Dolores River from a point immediately above the confluence with Horse Creek to a point immediately above the confluence with Bear Creek.		Aq Life Cold 1 Recreation 2 Agriculture	D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml	NH$_3$(ac)=TVS $_3$(ch)=0.02 Cl$_2$(ac)=0.019 Cl$_2$(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO$_2$=0.05	As(ch=50 Cd(ch)=.4 CrIII(ch)=100 CrVI(ch)=25 Cu(ch)=14	Fe(ch)=1000 Pb(ch)=4 Mn(ch)=1000 Hg(ch)=.05 Ni(ch)=50	Se(ch)=20 Ag(ch)=.1 Zn(ch)=240	All metals are Trec unless otherwise noted.
4. Mainstem of the Dolores River from a point immediately above the confluence with Bear Creek to the bridge at Bradfield Ranch (Forest Route 505) includes McPhee Reservoir.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH$_3$(ac)=TVS NH$_3$(ch)=0.02 Cl$_2$(ac)=0.019 Cl$_2$(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO$_2$=0.05 NO$_3$=10 Cl=250 SO$_4$=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
5. All tributaries to the Dolores River and West Dolores River, including all lakes and reservoirs, from the source to a point immediately below the confluence with the West Dolores River except for specific listings in Segments 1 and 6 through 10; mainstem of Beaver Creek (including Plateau Creek) from the source to the confluence with the Dolores River.		Aq Life Cold 1 Recreation 2 Water Supply Agriculture	D.O. = 6.0 mg/l D.O.(sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml	NH$_3$(ac)=TVS NH$_3$(ch)=0.02 Cl$_2$(ac)=0.019 Cl$_2$(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO$_2$=0.05 NO$_3$=10 Cl=250 SO$_4$=250	As(ch)=50 Cd(ch)=.4 CrIII(ch)=50 CrVI(ch)=25 Cu(ch)=5	Fe(ch)=300(dis) Fe(ch)=1000 Pb(ch)=4 Mn(ch)=50(dis) Mn(ch)=1000	Hg(ch)=.05 Ni(ch)=50 Se(ch)=10 Ag(ch)=.1 Zn(ch)=50	All metals are Trec unless otherwise noted.
6. Mainstem of the Slate Creek and Coke Over Creek, from their sources to their confluences with the Dolores River.		Aq Life Cold 1 Recreation 2 Water Supply Agriculture	D.O. = 6.0 mg/l D.O.(sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml	NH$_3$(ac)=TVS NH$_3$(ch)=0.02 Cl$_2$(ac)=0.019 Cl$_2$(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO$_2$=0.05 NO$_3$=10 Cl=250 SO$_4$=250	As(ch)=50 Cd(ch)=1.1 CrIII(ch)=50 CrVI(ch)=25 Cu(ch)=17	Fe(ch)=300(dis) Fe(ch)=1000 Pb(ch)=4 Mn(ch)=50(dis) Mn(ch)=1000	Hg(ch)=.05 Ni(ch)=50 Se(ch)=10 Ag(ch)=.1 Zn(ch)=50	All metals are Trec unless otherwise noted.
7. Mainstem of Coal Creek from the source to the confluence with the Dolores River.		Aq Life Cold 1 Recreation 2 Water Supply Agriculture	D.O. = 6.0 mg/l D.O.(sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH$_3$(ch)=0.02 Cl$_2$(ac)=0.019 Cl$_2$(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO$_2$=0.05 NO$_3$=10 Cl=250 SO$_4$=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
8. Mainstem of Horse Creek from the source to the confluence with the Dolores River.		Aq Life Cold 1 Recreation 2 Water Supply Agriculture	D.O. = 6.0 mg/l D.O.(sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml	NH$_3$(ac)=TVS NH$_3$(ch)=0.02 Cl$_2$(ac)=0.019 Cl$_2$(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO$_2$=0.05 NO$_3$=10 Cl=250 SO$_4$=250	As(ch)=50 Cd(ch)=.4 CrIII(ch)=50 CrVI(ch)=25 Cu(ch)=22	Fe(ch)=300(dis) Fe(ch)=1000 Pb(ch)=4 Mn(ch)=50(dis) Mn(ch)=1000	Hg(ch)=.05 Ni(ch)=50 Se(ch)=10 Ag(ch)=.1 Zn(ch)=100	All metals are Trec unless otherwise noted.
9. Mainstem of Silver Creek from a point immediately below the Town of Rico's water supply diversion to the confluence with the Dolores River.	UP	Aq Life Cold 2 Recreation 2 Agriculture	D.O. = 6.0 mg/l D.O.(sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml	NH$_3$(ac)=TVS NH$_3$(ch)=0.02 Cl$_2$(ac)=0.019 Cl$_2$(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO$_2$=0.05	As(ch)=50 Cd(ch)=6 CrIII(ch)=100 CrVI(ch)=25	Cu(ch)=20 Pb(ch)=16 Mn(ch)=1000 Hg(ch)=.05	Ni(ch)=50 Se(ch)=20 Ag(ch)=.1 Zn(ch)=1400	All metals are Trec unless otherwise noted.

STREAM CLASSIFICATIONS and WATER QUALITY STANDARDS

REGION: 9 BASIN: DOLORES RIVER Stream Segment Description	Desig	Classifications	NUMERIC STANDARDS: PHYSICAL and BIOLOGICAL	INORGANIC mg/l		METALS ug/l			TEMPORARY MODIFICATIONS AND QUALIFIERS
10. Mainstem of the West Dolores River from the source to the confluence with the Dolores River.		Aq Life Cold 1 Recreation 1 Water Supply Agriculture	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch)=TVS Se(ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
11. All tributaries to the Dolores River, including all lakes and reservoirs, from a point immediately below the confluence of the West Dolores River, to the bridge at Bradfield Ranch (Forest Route 505), except for the specific listing in Segment 5.	UP	Aq Life Cold 2 Recreation 2 Agriculture	D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH = 6.5-9.0 F.Coli=2000/100ml						

3.4.8 STATEMENT OF BASIS AND PURPOSE

I. Introduction

These stream classifications and water quality standards for State Waters of the San Juan River Basin including all tributaries and standing bodies of water and the Dolores River Basin including all tributaries and standing bodies of water south of the northern Dolores County line in all or parts of Archuleta, Conejos, Dolores, Hinsdale, La Plata, Mineral, Montezuma, Rio Grande and San Juan Counties implement requirements of the Colorado Water Quality Control Act C.R.S. 1973, 25-8-101 et seq. (Cum. Supp. 1981). They also represent the implemention of the Commission's Regulations Establishing Basic Standards and an Antidegradation Standard and Establishing a System for Classifying State Waters, for Assigning Standards, and for Granting Temporary Modifications (the "Basic Regulations")

The Basic Regulations establish a system for the classification of State Waters according to the beneficial uses for which they are suitable or are to become suitable, and for assigning specific numerical water quality standards according to such classifications. Because these stream classifications and standards implement the Basic Regulations, the statement of basis and purpose (Section 3.1.16) of those regulations must be referred to for a complete understanding of the basis and purpose of the regulations adopted herein. Therefore, Section 3.1.16 of the Basic Regulations is incorporated by reference. The focus of this statement of basis and purpose is on the scientific and technological rationale for the specific classifications and standards in the San Juan River Basin.

Public participation was a significant factor in the development of these regulations. A lengthy record was built through public hearings held on May 14, 1981. A total of 10 entities requested and were granted party status by the

Commission in accordance with C.R.S. 1973, 24-4-101 et seq. (Cum. Supp. 1980). A supplementary public rulemaking hearing was held September 15, 1981, restricted to those issues raised by the changes in the Act contained in Senate Bill 10 (1981). Such issues included but were not limited to: "The economic reasonableness" evaluation required by 25-8-102(5), the effect on water rights as required by 25-8-104; and the new considerations for the adoption of water quality standards required by 25-8-204 C.R.S. 1973, as amended. The record established in these hearings forms the basis for the classifications and standards adopted.

II. General Considerations

1. These regulations are not adopted as control regulations. Stream classifications and water quality standards are specifically distinguished from control regulations in the Water Quality Control Act, and they need not be adopted as control regulations pursuant to the statutory scheme.

2. The Commission has been requested in public hearings to rule on the applicability of these and other regulations to the operation of water diversion facilities, dams, transport systems, and the consequent withdrawal, impoundment, non-release and release of water for the exercise of water rights. The Commission has determined that any such broad ruling is inappropriate in the context of the present regulations. The request does not raise specific questions as to proposed classifications and standards. However, the Commission has taken into account the fact that some issues are unresolved in adopting classifications and standards. On January 5, 1981, the Commission adopted a policy statement on quality/quantity issues that addresses a number of these concerns. Finally, the Commission has adopted these regulations in compliance with the requirements of the Water Quality Control Act that have bearing on these issues (See e.g.) sections 102, 104, and 503(5).

III. Definition of Stream Segments

1. For purposes of adopting classifications and water quality standards, the streams and water bodies are identified according to river basin and specific water segments.

2. Within each river basin, specific water segments are defined, for which use classifications and numeric water quality standards, if appropriate, are adopted. These segments may constitute a specified stretch of a river mainstem, a specific tributary, a specific lake or reservoir, or a generally defined grouping of waters within the basin (e.g., a specific mainstem segment and all tributaries flowing into that mainstem segment).

3. Segments are generally defined according to the points at which the use, water quality, or other stream characteristics change significantly enough to require a change in use classification and/or water quality standards. In many cases, such transition points can be specifically identified from available data. In other cases the delineation of segments is based upon best judgments of the points where instream changes in uses, water quality, or other stream characteristics occur.

IV. Use Classifications -- Generally

1. Initially, recommendations for stream segmentation and use classifications are a result of input from 208 plans, water quality data and reports, the Division of Wildlife, and personal knowledge. After a basic outline of stream segments and use classifications was prepared, water quality data from a variety of sources was compared against the "table value" for the proposed use. "Table value" refers to the four tables attached to the "Basic Regulations". In general, if the mean plus one standard deviation ($\bar{x}$ + s) of the available data for the segment indicated that a particular parameter did not exceed the "table value" for that

recommended use, the "table value" was listed as the recommended standard for the parameter. If the $\bar{x}$ + s computation indicated that the instream concentrations of the parameter exceeded the "table value" and yet the use to be protected by that parameter was in place, then the $\bar{x}$ + s value was recommended as the standard for that parameter.

Conversely, if the ambient quality ($\bar{x}$ + s) for a certain parameter exceeded the "table value" for the protection of a use, and there is information that the use is <u>not</u> in place, the use classification was modified or temporary modifications to the parameters were established. Ambient quality is generally defined as the quality attributable to natural conditions and/or uncontrollable non-point sources.

One exception to the procedure just described is for whole body contact recreation (class 1). If an active domestic waste discharge was located on the segment in question, class 1 recreation was not recommended regardless of the ambient quality, unless there was information to show that the segment was actually used for swimming. This policy was established by the WQCC in order to avoid penalizing a discharger for protecting a use which is not in place and to limit possible harm to aquatic life due to chlorine residuals.

2. The use classifications have been established in accordance with the provisions of Section 203 of the Water Quality Control Act and Section 3.1.6 and 3.1.13 of the Basic Regulations.

3. In all cases the basic regulation has been followed, in that an upstream use cannot threaten or degrade a downstream use. Accordingly, upstream segments of a stream are generally the same as, or higher in classification than, downstream segments. In a few cases, tributaries are classified at lower classifications than mainstems, where flow from tributaries does not threaten the quality of mainstem waters and where the evidence indicates that lower classification for the tributaries is appropriate.

4. There have been no "High Quality Class 1" designations assigned in this basin.

5. The Commission has determined that it has the authority to assign the classification "High Quality Waters - Class 1" and "High Quality Waters - Class 2" where the evidence indicates that the requirements of Sections 3.1.13(1)(e) of the basic regulations are met. The appropriateness of this classification has been determined on a case-by-case basis. Streams have in some cases been classified "High Quality - Class 2" for one or more of the following reasons:

   (a) to facilitate the enjoyment and use of the scenic and natural resources of the State in accordance with the Legislative Declaration of the Colorado Water Quality Control Act (25-8-102(1) C.R.S. 1973.

   (b) to provide a high degree of protection deserving of wilderness areas which are a resource providing a unique experience.

   (c) they contain threatened species or apply to wild and scenic river study areas or wilderness areas.

   (d) the concern of the USFS that High Quality 2 classification will unduly burden their management of multiple use areas is not well founded. This is because activities on Forest Service land, i.e. grazing, mineral exploration, trail and road maintenance, are considered as a historical impact upon existing ambient water quality conditions, and are non point sources which are presently not subject to any Water Quality Control Commission regulations.

   (e) a question exists as to whether existing diversion structures can be maintained consistent with a "High Quality - Class 1" designation. Because of the questions regarding authority to regulate diversions, the Class 1 designation was deemed potentially too rigid. The Commission recognizes its authority to upgrade these segments if and when it is appropriate to do so.

6. In accordance with 25-8-104, C.R.S. 1973, the Commission intends that no provision of this regulation shall be interpreted so as to supercede, abrogate, or impair rights to divert water and apply water to beneficial uses.

7. Qualifiers -- Seasonal and Intermittant

These qualifiers have been used to more fully describe characteristics of certain stream segments.

8. Recreation -- Class 1 and Class 2

In addition to the significant distinction between Recreation - Class 1 and Recreation - Class 2 as defined in Section 3.1.13(1) of the Basic Regulations, the difference between the two classifications in terms of water quality standards is the fecal coliform parameter. Recreation - Class 1 generally has a standard of 200 fecal coliform per 100 ml; Recreation - Class 2 generally has a standard of 2000 fecal coliform per 100 ml.

In accordance with the Colorado Water Quality Control Act, the Commission has decided to classify as "Recreation - Class 2" those stream segments where primary contact recreation does not exist and cannot be reasonably expected to exist in the future, regardless of water quality. The Commission has decided to classify as "Recreation - Class 1" only those stream segments where primary contact recreation actually exists, or could reasonably be expected to occur. The reasons for the application of Recreation Class 2 are as follows:

(a) The mountain streams in this region are generally unsuitable for primary contact recreation because of water temperature and stream flows.

(b) Fecal coliform is an indicator organism. Its presence does not always indicate the presence of pathogens. This depends on the source of the fecal coliform. If the source is agricultural runoff as opposed to human sewage, there may be no health hazard and therefore no significant need to reduce the presence of fecal coliform to the 200 per 100 ml. level. Also, control of nonpoint sources is very difficult.

(c) Treating sewage to meet the 200 per 100 ml. level generally means the treatment plant must heavily chlorinate its effluent to meet the limitation. The presence of chlorine in the effluent can be significantly detrimental to aquatic life. Post-treatment of effluent to meet the residual chlorine standard is expensive and often results in the addition of more chemicals which have a negative effect on water quality and can be detrimental to aquatic life. Therefore, reducing the need for chlorine is beneficial to aquatic life.

(d) Even where a treatment plant in this region might treat its effluent to attain the standard of 200 per 100 ml., agricultural runoff and irrigation return flows below the plant may result in the rapid increase of fecal coliform levels. Therefore, the benefits of further treatment are questionable.

(e) The fecal coliform standard of 2000 per 100 ml. has been established to provide general public health protection. There is no significant impact on domestic drinking water treatment plants because they provide complete disinfection. The standard of 200 per 100 ml. is not intended to protect the water supply classification.

9. <u>Water Supply Classification</u>

The Commission finds that Colorado is a water short state and that it is experiencing considerable growth which places additional burdens on already scarce water supplies. These considerations mitigate in favor of a conservative approach to protecting future water supplies. Where existing water quality is adequate to protect this use, and in the absence of dischargers to these segments or testimony in opposition to such classification, the water supply use has been assigned because it is reasonable to expect that it may exist in the future in such cases. For stream segments that flow through, or in the vicinity of, municipalities, this conclusion is further justified, since there is a reasonable probability that the use exists or will exist. Where the water supply classification has been opposed, the Commission has evaluated the evidence on a site specific basis, and in many cases the classification has been removed.

V. Water Quality Standards — Generally

1. The water quality standards for classified stream segments are defined as numeric values for specific water quality parameters. These numeric standards are adopted as the limits for chemical constituents and other parameters necessary to protect adequately the classified uses in all stream segments.

2. Not all of the parameters listed in the "Tables" appended to the Basic Regulations are assigned as water quality standards. This complies with Section 3.1.7(c) of the Basic Regulations.

   Numeric standards have been assigned for the full range of parameters to a number of segments where little or no data existed specific to the segment. In these cases, there was reason to believe that the classified uses were in place or could be reasonably expected, and that the ambient water quality was as good as or better than the numeric standards assigned.

3. A numeric standard for the temperature parameter has been adopted as a basic standard applicable to all waters of the region in the same manner as the basic standards in Section 3.1.11 of the Basic Regulations.

   The standard of a 3° C temperature increase above ambient water temperature as defined is generally valid based on the data regarding that temperature necessary to support an "Aquatic Life - Class 1" fishery. The standard takes into account daily and seasonal fluctuations; however, it is also recognized that the 3°C limitation as defined is only appropriate as a guideline and cannot be rigidly applied if the intention is to protect aquatic life. In winter, for example, warm water discharges may be beneficial to aquatic life. It is the intention of the Commission in adopting the standard to prevent radical temperature changes in short periods of time which are detrimental to aquatic life.

4. Numeric standards for seventeen organic parameters have been adopted as basic standards applicable to all waters of the region in the same manner as the basic standards in Section 3.1.11 of the Basic Regulations. These standards are essential to a program designed to protect the waters of the State regardless of specific use classifications because they describe the fundamental conditions that all waters must meet to be suitable for any use.

   It is the decision of the Commission to adopt these standards as basic standards because the presence of the organic parameters is not generally suspected. Also, the values assigned for these standards are not detectable using routine methodology and there is some concern regarding the potential for monitoring requirements if the standards are placed on specific streams. This concern should be alleviated by Section 3.1.14(5) of the Basic Regulations but there is uncertainty regarding the interpretation of those numbers by other entities. Regardless of these concerns, because these constituents are highly toxic, there is a need for regulating their presence in State waters. Because the Commission has determined that they have uniform applicability here, their inclusion as basic standards for the region accomplishes this purpose.

5. In many cases, the numeric water quality standards are taken from the "Tables" appended to the Basic Regulations. These table values are used where actual ambient water quality data in a segment indicates that the existing quality is substantially equivalent to, or better than, the corresponding table values. This has been done because the table values are adequate to protect the classified uses.

Consistent with the Basic Regulations, the Commission has not assumed that the table values have presumptive validity or applicability. This accounts for the extensive data in the record on ambient water quality. However, the Commission has found that the table values are generally sufficient to protect the use classifications. Therefore, they have been applied in the situations outlined in the preceeding paragraph as well as in those cases where there is insufficient data in the record to justify the establishment of different standards. The documentary evidence forming the basis for the table values is included in the record.

6. In many cases, instream ambient water quality provides the basis for the water quality standards (See 7 below). In those cases where the classified uses presently exist or have a reasonable potential to exist despite the fact that instream data reflects ambient conditions of lower water quality than the table values, instream values have been used. In these cases, the evidence indicates that instream values are adequate to protect the uses. In those cases where temporary modifications are appropriate, instream values are generally reflected in the temporary modification and table values are reflected in the corresponding water quality standard. (Goals are established for the appropriate classification affected by the parameter).

Cases in which water quality standards reflect these instream values usually involve the metal parameters. On many stream segments elevated levels of metals are present due to natural or unknown causes, as well as mine seepage from inactive or abandoned mines. These sources are difficult to identify and impractical or impossible to control. The classified aquatic life uses may be impacted and/or may have adjusted to the condition. In either case, the water quality standards are deemed sufficient to protect the uses that are present.

7. The Commission rejected the proposal to assign only "temporary" standards pending additional data collection to verify or modify values assigned. Concerned parties concurred that triennial review will lead to updating of standards as necessary. Furthermore, limited financial resources will be focused upon streams with permitted discharges.

8. In those cases where there was no data for a particular segment, or where the data consists of only a few samples for a limited range of parameters, "table values" were generally recommended. Data at the nearest downstream point was used to support this conclusion. In some cases, where the limited data indicated a problem existed, additional data was collected to expand the data base. Additionally, where there may not be existing data on present stream quality, the Commission anticipates that if necessary, additional data will be collected prior to a hearing required by C.R.S. 1973, 25-8-204(3), as amended.

9. In most cases in establishing standards based on instream ambient water quality, a calculation is made based upon the mean (average) plus one standard deviation ($\bar{x} + s$) for all sampling points on a particular stream segment. Since a standard deviation is not added to the water quality standard for purposes of determining the compliance with the standard, this is a fair method as applied to discharges.

Levels that were determined to be below the detectable limits of the sampling methodolgy employed were averaged in as zero rather than at the detectable limit. This moves the mean down but since zero is also used when calculating wasteload allocations, this method is not unfair to dischargers.

Metals present in water samples may be tied up in suspended solids when the water is present in the stream. In this form they are not "available" to fish and may not be detrimental to aquatic life. Because the data of record does not distinguish as to availability, some deviation from table values, as well as the use of $\bar{x} + s$, is further justified because it is unlikely that the total value in all samples analyzed is in available form.

A number of different statistical methodologies could have been used where ambient water quality data dictates the standards. All of them have both advantages and disadvantages. It is recognized that the $\bar{x} + s$ methodology also has weaknesses, in that the standard may not reflect natural conditions in a stream 100 per cent of the time, even though the use of $\bar{x} + s$ already allows for some seasonal variability. However the use of this methodology is nevertheless justified since it provides the most meaningful index of stream quality of all methodologies proposed for setting stream standards.

Finally, the fairness and consistency of the use of any methodology in setting standards must turn on the manner in which the standards are implemented and enforced. It is essential that there be consistency between standard setting and the manner in which attainment or non-attainment of the standards is established based on future stream monitoring data. In addition the Division must take this methodology into account in writing and enforcing discharge permits.

10. No water quality standards are set below detectable limits for any parameter, although certain parameters may not be detectable at the limit of the standards using routine methodology. However, it must be noted that stream monitoring, as opposed to effluent monitoring, is generally not the responsibility of the dischargers but of the State. Furthermore, the purpose of the standards is to protect the classified uses and some inconvenience and expense as to monitoring is therefore justifiable.

    Section 3.1.15(5) of the Basic Regulations states that "dischargers will not be required to regularly monitor for any parameters that are not identified by the Division as being of concern". Generally, there is no requirement for monitoring unless a parameter is in the effluent guidelines for the relevant industry, or is deemed to be a problem as to a specific discharge.

11. The dissolved oxygen standard is intended to apply to the epilimnion and metalimnion strata of lakes and reservoirs. Respiration by aerobic micro-organisms as organic matter is consumed is the primary cause of a natural decrease in dissolved oxygen and anaerobic conditions in the hypolimnion. Therefore, this stratum is exempt from the dissolved oxygen standard.

12. Where numeric standards are established based on historic instream water quality data at the level of $\bar{x} + s$, it is recognized by the Commission that measured instream parameter levels might exceed the standard approximately 15 percent of the time.

13. It is the Commission's intention that the Division implement and enforce all water quality standards consistent with the manner in which they have been established.

14. <u>Hardness/Alkalinity</u>

Where hardness and alkalinity numbers differed, the Commission elected to use alkalinity as the controlling parameter, in order to be consistent with other river basins and because testimony from the Division staff indicated that in most cases alkalinity has a greater effect on toxic form of metals than does hardness.

VI. <u>Water Quality Standards for Unionized Ammonia</u>

On some Class 2 Warm Water Aquatic Life streams containing similar aquatic life communities to those found in the plains streams of the South Platte & Arkansas Basins, .1 mg/l ammonia was selected as being appropriate to protect such aquatic life.

These streams generally contain both lesser numbers and types of species than those inhabiting class 1 streams due to physical habitat characteristics, flow or irreversible water quality characteristics. The Commission felt that the incremental expense to meet a 0.06 mg/l unionized ammonia standard for present or potential discharges along these streams cannot be justified. Low flow, in these segments is often intermittent or highly impacted by diversions.

Specifically, the Commission has relaxed unionized ammonia standards to .1 mg/l or greater on such streams for the following reasons:

1. limited nature of the aquatic life present;

2. limited recreational value of species present;

3. habitat limitations, primarily flow and streambed characteristics, that impose significant limitations on the nature of aquatic life, even if ammonia reductions were attained;

4. rapid dissipation of ammonia in streams, reducing the impact of such discharges downstream; and

5. economic costs of ammonia removal, especially where such costs would fall primarily on publicly-owned treatment works, and while the availability of construction grant funds is questionable.

6. Biosurveys with support from a bioassay conducted on fathead minnows performed in the Cache la Poudre River, show that a .1 mg/l standard is appropriate to protect existing biota in that stream. The results of these studies may be reasonably extrapolated to similar plains streams; i.e., those streams that demonstrate similar chemical, physical, and biological characteristics.

Not all warmwater streams are comparable in terms of flow habitat, and types and numbers of species of aquatic life. Therefore, some variations in an appropriate ammonia standard must be tolerated, with the objective of protecting existing aquatic life. The Commission found this approach preferable to totally removing the aquatic life classsification from impacted or marginal aquatic life streams.

VII. Water Quality Standards for Uranium

Given the threat that radioactivity from uranium may pose to human health, it is advisable to limit uranium concentrations in streams to the maximum extent practicable. The Commission has adopted a standard of 40 pCi/l or natural background where higher, for the following reasons:

1. 40 pCi/l generally reflects background concentrations of uranium that may be found in streams in Colorado and therefore this amount approximates routine human exposure.

2. The statistical risk of human health hazards is small at 40 pCi/l.

3. 40 pCi/l is an interim level, established now pending the outcome of further studies currently underway.

VIII. Water Quality Standards for Cyanide

The Commission acknowledges that total cyanide is to be used in State Discharge permits until a method is authorized by EPA for measuring free cyanide, even though free cyanide is the parameter of concern. While cyanide has received special treatment in cases discussed in the segment - by - segment section which follows, a free cyanide standard based on Table Values has been established for most segments.

IX. Linkage of classifications and Standards

The Commission holds that the classifications which it adopts and the standards it assigns to them are linked. Disapproval by EPA of the standards may require reexamination by the Commission of the appropriateness of its original classification.

The reason for the linkage is that the Commission recognizes that there is a wide variability in the types of aquatic life in Colorado streams which require different levels of protection. Therefore, the numbers were chosen in some cases on a site specific basis to protect the species existing in that segment. If any reclassification is deemed a downgrading, then it will be based upon the grounds that the original classification was in error.

X. Economic Reasonableness

The Commission finds that these use classifications and water quality standards are economically reasonable. The Commission solicited and considered evidence of the economic impacts of these regulations. This evaluation necessarily involved a case-by-case consideration of such impacts, and reference is made to the fiscal impact statement for this analysis. Generally, a judgment was made as to whether the benefits in terms of improving water quality justified the costs of increased treatment. In the absence of evidence on economic impacts for a specific segment, the Commission concluded that the regulations impose no unreasonable economic burden.

XI. Classifications and Standards - Special Cases

1. Page 1, Segment 2 - San Juan River in Archuleta County (proposed as page 1, segment 2)

At issue was the recommendation contained in the Regional Water Quality Management "208" Plan that flow deficiencies and silt attributable to the San Juan - Chama diversion limited use of the segment to agriculture. Although both warm and cold water species, including trout, were observed in the segment, the Commission found from the evidence that there was perennial flow sufficient to support the aquatic life use proposed.

In view of controversy in the testimony concerning flow, the Commission considered the recommendation in the "208 Plan, yet classified the aquatic life use as class 1, cold water because other testimony indicated that recorded stream flows were ample to support aquatic life.

2. <u>Page 2, Segment 8</u>

   This segment was incorporated into segment 5 of page 1.

3. <u>Page 2, Segment 10</u>

   The "208" Plan was relied on by the Commission and no other evidence on this segment was presented.

4. <u>Page 3, Segment 3 - Piedra River</u>

   The Commission retained the cold water aquatic life class 1 classification after finding that although one small portion of the segment may be intermittent, due to diversion, it quickly remakes itself and the intermittent portion is very small compared with the total length of the segment. The Commission also notes that it's decision will have no impact on any discharger.

5. <u>Page 4, Segment 2(a) and 2(b) Los Pinos River (proposed as page 4, segment 2)</u>

   The resegmentation recommended by the Division is consistent with segmentation described in the Regional "208" Plan.

6. <u>Page 6, Segment 2 - Animas and Florida Rivers</u>

   This is a large segment, exhibiting many water quality variables throughout its length. Although there is some evidence of insect life at points in the segment, the evidence regarding the presence of aquatic life is contradictory, and there is no evidence of fish life being present. In the absence of sufficient data to support the classification of any portion of this segment for aquatic life, the current status is being retained and no aquatic life use is assigned. The Commision expects further information to be developed through studies sponsored by the Standard Metals Corporation and the Division.

The Commission declined to assign an agricultural classification to the segment due to the absense in the record of any evidence of an agricultural use in the segment.

7. Page 6, Segment 6

Since Cement Creek and its tributaries are degraded by abandoned mine drainage and past discharges, the Commission did not assign aquatic and agricultural classifications to the segment as had been proposed. The segment does not currently have an aquatic life classification, and thus the status quo is maintained. The Commission placed recreation in the class 2 category as the basic use and found no agricultural use to be in place.

8. Page 7, Segment 7

The Woodling Study indicates that Mineral Creek from its source to its confluence with South Mineral Creek is highly toxic due to mineralization and there is not a liklihood that the sources of that toxicity will be corrected in 20 years. However the Commission concluded that there was likely to be aquatic life in that portion of Mineral Creek from below South Fork to Silverton. By changing the stream segment description such that it covers the mainstem of Mineral Creek including all tributaries from the source to a point immediately above the confluence with South Mineral Creek, the Commission was enabled to preserve the aquatic life classification on South Mineral Creek and the remaining portion of Mineral Creek into Silverton.

9. <u>Page 8, Segment 12(a) and 12(b)</u> <u>(proposed as page 6, segment 12)</u>

Lemon Reservoir was resegmented as 12(a) for the purposes of classifying it Recreation Class 1 in recognition of known use appropriate to that classification.

10. <u>Page 8, Segment 13(a) and 13(b)</u> <u>(proposed as page 7, segment 13)</u>

Segment 13 included Junction Creek. The Resegmentation was to separate Junction Creek as 13(a) so that different standards could be assigned to it to protect its use as a water supply for a fish hatchery. The Commission felt that the testimony supported: (a) classification of the stream for cold water aquatic life class 2 because of poor habitat and low flow conditions; and (b) assignment of numeric standards to protect the fish hatchery. The Commission felt that the use was in place and that the assignment of these standards was economically reasonable. It does not appear that discharges from trailer parks into this segment adversely impact this use. There was insufficient evidence in the record for the Commission to conclude that there would be any economic impact on such dischargers.

11. <u>Page 8, Segment 15</u>

Testimony was received by the Commission from the Purgatory Water and Sanitation District that the water supply classification was not applicable below the reservoir. The Commission concurred and determined that there should be no more than a class 2 aquatic life classification for this segment because of its intermitant flow and poor habitat characteristics. It was recommended that recreation class 2, agriculture and water supply be designated for the protection of the reach above the reservoir. Despite opposition to the water supply classification by Purgatory Water and Sanitation District based upon the absence of such use below Duncan Reservoir, the Commission finds that the presence of this use at other locations justifies the classification. This should not impact the District because the numeric standards for protection of the use are less stringent than those for protection of aquatic life and should be met by the discharger without additional treatment facilities.

12.. Page 11, Segment 3 - Dolores River in Dolores County

Even though the regional "208" Plan recommended that the segment be classified for a water supply use, the Commission received no testimony that there was such use in the segment. Because of high levels of manganese and the lack of evidence of in place water supply use, the Commission did not so classify the segment. Anaconda Corporation proposed numeric standards for silver and mercury. The Division recommended to the Commission that it not utilize the Anaconda proposals for those constituents because they were based on limited data, unusually high values, and questionable analytical techniques. It had not been documented that the levels of those constituents proposed by Anaconda had been routinely found in the stream. Due to this lack of certainity with respect to these metals values, the Commission did not choose to use the Anaconda data on mercury an silver.

COLORADO DEPARTMENT OF HEALTH
Water Quality Control Division
4210 E. 11th Avenue
Denver, CO 80220

FISCAL STATEMENT

Stream Classifications and Water Quality Standards for State Waters of the San Juan and Dolores River Basins including all tributaries and standing bodies of water south of the northern Dolores County line in all or parts of Archuleta, Conejos, Dolores, Hinsdale, La Plata, Mineral, Montezuma, Rio Grande, and San Juan Counties.

I. INTRODUCTION

The Water Quality Control Commission is charged with the responsibility to conserve, protect, and improve the quality of state waters pursuant to C.R.S. 1973, 25-8-101 et seq.

The Commission is further empowered and directed to classify waters of the State and to promulgate water quality standards for any measurable characteristic of the water in order to protect both the uses in place and those that can be reasonably expected in the future. (25-8-203 and 25-8-204) The above-titled document assigns use classifications and standards for the state waters in the listed areas in accordance with the "basic regulations" adopted May 22, 1979.

The measurable fiscal impacts which may be caused by these regulations are as follows:

- Cost of construction due to requirements for increased levels of treatment by municipal waste treatment facilities;
- Cost of construction due to requirements for increased levels of treatment by industrial/commercial waste treatment facilities;
- Cost of Operation and Maintenance associated with increased levels of treatment required of municipalities;
- Cost of instream monitoring and laboratory analysis for new parameters added by the standards.

Dischargers will not be required by the adoption of these regulations to do stream monitoring. The state, federal and local agencies now doing instream monitoring will have some increased cost; however, any additional frequency should be done to improve state surveillance and would be needed regardless of standard changes.

The stream classifications and standards adopted by the Commission will protect the water uses primarily through control of point source pollution. Non-point source pollution will be controlled primarily through management practices which are in existence or which will be implemented in the future. Future management practices need careful consideration and may be the result of 208 area-wide wastewater management plans developed by regional planning agencies and being updated annually. These plans involve local governments with general assistance from state government. Some of the possible non-point source pollution may be controlled through "Control Regulations" yet to be promulgated by the Commission. These types of controls could involve runoff from construction, mining activites, and urban areas. It is not certain what controls are needed at this time and there is no way that possible costs can be identified at this time.

Persons who benefit from standards which will protect existing and future anticipated uses can be identified as all persons benefiting from recreation, municipal water supply, and agriculture. These benefits are directly economic for agriculture, industry, and municipalities whose health benefit costs are reduced by having clean water, and are both economic and non-quantifiable for some uses such as fishing, recreation, and the aesthetic value of clean waters. Furthermore, benefits will result from human health protection and lack of debilitating disease. Figures have been developed for a recreation/fishing day which can be applied to that aspect of a water use; however, figures which have been developed for total recreation/fishing day uses have been developed statewide and could not be applied region-by-region or stream-by-stream.

The uses of water in this region are adequately protected by these standards. Most municipal treatment facilities and industrial facilities are currently adequate, or are already being upgraded, in order to meet previous requirements. Any additonal facilities or expansions in this region will generally be caused by increased capacity required because of population growths or industrial enlargement. Industries are required by federal statute to meet effluent limitations described as "Best Available Technology Economically Achievable" (BATEA) by 1983 or 1984. For most major industries in this region, the water quality standards should not require treatment beyond these limitations.

The fiscal impact of any regulatory decision must take into account only the incremental costs explicitly associated with the regulations as finally promulgated. Costs and expenditures associated with the status quo, regulations of other regulatory agencies, or regulations already in effect should not be included in an assessment of the fiscal impact of the San Juan and Dolores River Basins classifications.

In addition, a distinction must be made between actual expenditures or dislocations that will be immediately or unavoidably necessary upon promulgation of these classifications and standards, and those costs which are speculative in nature. In keeping with concepts of 'Expected Value', it is proper for the Commission to place more emphasis on definite impacts.

With the passage in 1981 of Senate Bill 10, amending the Colorado Water Quality Control Act, it became incumbent upon the Water Quality Control Commission to consider the economic impact of their decisions with more emphasis placed upon the concept of the "Economic Reasonableness". Supplementary hearings were held by the Commission on the San Juan and Dolores River Basins to consider the new provisions of the Act. Charged with such a mandate, the Commission was quite sensitive to the objective of minimizing the socio-economic "price" of clean water while adhering to the anti-degradation policy that water quality be preserved and protected in all cases, and improved wherever feasible.

The analysis and data which follow are derived primarily from testimony and exhibits offered by interested parties during the course of the rulemaking hearings. This was supplemented by staff assessments of potential impacts upon other major entities who were not formally represented. The impacts are separately presented for the public and private sectors. No attempt has been made to identify future development costs as this type of data is not readily available and estimation techniques are dependent upon many highly subjective assumptions.

II. FISCAL IMPACT: PUBLIC SECTOR

The primary fiscal impact upon the public sector in these basins involves the potential for increased domestic wastewater treatment costs associated with the stream classifications and water quality standards. Other costs, such as tax and employment base impacts due to forgone industrial development opportunities or mitigated growth potentials, can be theoretically postulated but are difficult to quantify. Generally, it is recognized that higher tap fees, service charges or property taxes associated with increased treatment costs can potentially affect industrial and residential siting decisions. While the Commission acknowledges the existence of such potentials, the lack of firm evidence and actual tax base impact estimates make deliberative assessment impractical.

In these basins the Commission acknowledged five municipalities that could be potentially impacted: Durango, Forest Lake, Bayfield, Ignacio, and the Purgatoire Water and Sanitation District. In each case, the ammonia standard was the controlling factor. Additional data led to the conclusion that Durango should not need to go beyond secondary treatment.

Low flow in the Pinos River and/or increased treatment flows could cause an ammonia impact upon Forest Lake, Bayfield and Ignacio. Currently, secondary treatment is all that is required of these municipalities under existing permits. None of these entities presented testimony that indicated an immediate or impending impact due to ammonia requirements so the actual fiscal impact, if any, cannot be properly assessed.

The Purgatoire Water and Sanitation District presented testimony indicating the necessity of tertiary treatment (AWT) at a cost of $480,000 if the stream were classified as proposed with an Aquatic Class One designation. This designation was not adopted so it is believed that Purgatoire will not incur a cost as a result of these classifications and standards.

III. FISCAL IMPACT: PRIVATE SECTOR

Several entities presented testimony regarding water rights issues but there was no firm evidence indicating any specific water rights impacts and no cost estimates were provided. These basins have a sparse industrial/commercial density and it is believed that these regulations will have a minimal impact upon the private sector.

While metals standards could impose an impact upon unidentified entities, it is impossible to identify who they might be and to what extent they might be impacted. In any event, any active operation is already covered by permit and, in lieu of specific testimony, it must be assumed that no recognizable impacts will result from these classifications and standards.

In recognition of the benefits to be derived from protecting aquatic life and public water supply and that no immediate fiscal impacts will result from this regulation, it is concluded that the Commission acted in an economically responsible and reasonable manner.

PARTIES TO THE SAN JUAN RIVER AND DOLORES RIVER BASINS

1. Anaconda Copper Company
2. Purgatory Water and Sanitation District
3. Climax Molybdenum
4. Pagosa Area Water and Sanitation District
5. Golf Host West, Inc.
6. Eaton International Corp.
7. City of Durango
8. Trout Unlimited
9. Daniel McCarthy
10. Chevron Resources, Inc.

STATEMENT OF BASIS AND PURPOSE REGARDING THE ADOPTION OF NON-SUBSTANTIVE CORRECTIONS TO THE CLASSIFICATIONS AND NUMERIC STANDARDS FOR THE ARKANSAS, SAN JUAN AND DOLORES, RIO GRANDE AND SOUTH PLATTE RIVER BASINS.

In accordance with the requirements of 24-4-103(4), C.R.S. 1973, the Commission makes these findings and adopts this Statement of Basis and Purpose.

The Commission at a public rulemaking hearing November 8, 1982, adopted clerical and editorial corrections to the Commission's current regulations numbered respectively 3.2.0, 3.4.0, 3.6.0, and 3.8.0. These regulations are contained in Article 3, Water Quality Standards, of the Policies, Regulations, and Guidelines of the Water Quality Control Commission. (5CCR 1002-8)

In adopting these corrections the Commission considered the economic reasonableness of its action, except as specified the corrections in no way change the classifications and numeric standards originally adopted by the Commission. Other than written comment from the City of Westminster no testimony was offered at the public hearing.

The consolidated changes adopted by the Commission are included in this Basis and Purpose for information. The Secretary of State was provided corrected pages for each of the regulations as replacements for the regulations previously published.

Dated this 8th day of November, 1982 at Denver, Colorado.

FISCAL STATEMENT

Regarding The Adoption of Non-Substantive Corrections To The Classifications And Numeric Standards For The Arkansas, San Juan and Dolores, Rio Grande and South Platte River Basins.

The Water Quality Control Commission found that clerical and editorial corrections to the Commission's current regulations numbered respectively 3.2.0, 3.4.0, 3.6.0, and 3.8.0 have no fiscal impact.

Dated this 8th day of November, 1982 at Denver, Colorado.

3.4.9 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE:

The provisions of 25-8-202(1)(a)(b) and (2); and 25-8-204 C.R.S. provide the specific statutory authority for the numeric standards that were adopted.

The Commission also adopted in compliance with 24-4-103(4) C.R.S. the following statements of basis and purpose and fiscal impact.

BASIS AND PURPOSE - SAN JUAN AND DOLORES RIVER BASINS

The basis and purpose for the changes by segment is as follows:

Segment 6, Piedra River - This segment contains the lakes listed for inclusion in the proposed Segment 7. In order to separate these lakes from this segment, the description must be changed.

Segment 7, Piedra River - The lakes listed are all fisheries and a majority of them are used for sport fishing. Their present inclusion in Segment 6 does not represent their actual use, i.e., Class 1 Aquatic Life, or provide standards to protect this use. The Commission has classified all reservoirs in Segment 7 as Warm Water Class 1 instead of Cold Water Class 1 on the basis that: 1) all reservoirs are already heavily managed, including aeration; 2) trout have been introduced into the reservoirs and do not occur naturally; and 3) at least temperature excursions above that require for cold water classification occur.

The Commission notes that the data base supporting this change in classification to warm water Class 1 is not extensive and further water quality monitoring is encouraged.

Segment 15, Animas River - Studies conducted by the Water Quality Control Division indicate that both Goulding Creek and Nary Draw are intermittent streams more appropriately classified under Segment 15 than under Segment 12a. The change in the description of Segment 15 will accomplish this and provide adequate protection of the uses.

Adopted: December 6, 1985
Effective: January 30, 1986

Segment 8, La Plata River, Mancos River, McElmo Creek, and San Juan River - The change in description to include Dolores County will include those streams which are unclassified under the existing description.

Change in basin description at top of pages 9 and 10 of the Tables - Change is needed to accurately reflect the streams included in this section with the change in description of Segment 8.

FISCAL IMPACT STATEMENT - SAN JUAN AND DOLORES RIVER BASINS

As these changes are in response to an increasing body of knowledge concerning accurate classifications of uses and the standards necessary to maintain those uses, they are not economically driven. The only discharger in the basins, Pagosa Area Water & Sanitation District, is moving their discharge from Pagosa Lakes and will not be adversely harmed by these standards. Recognition of higher classifications and inclusion of new classifications are benefits in light of the goals of the Water Quality Control Act and these regulations will serve to maintain and enhance those uses. Recognition of intermittent streams and subsequent Class 2 designations will have the potential of decreased treatment costs if development occurs near them in the future. As no adverse economic impact is anticipated by these regulations, and because they more accurately protect existing and potential beneficial uses, the Commission regards these changes as economically reasonable.

Adopted: December 6, 1985
Effective: January 30, 1986

3.4.10 BASIS AND PURPOSE:

At the triennial review of the San Juan and Dolores River Basins in May, 1985, the Water Quality Control Division pointed out that the Division had recently (April, 1985) granted a variance to the limitation for cadmium in Anaconda Company's Rizo Mine discharge permit. The underlying stream concentration which was used to support the variance was 0.002 mg/l, and was based upon an $\bar{x}$ + s calculation of fifteen cadmium data points above the St. Louis ponds discharge collected in 1981. The rationale for the variance anticipated the establishment of a revised cadmium standard through the established standards setting procedure of the Water Quality Control Commission, and noted that subsequent to that procedure, an amended discharge limitation in Anaconda's discharge permit would be written.

This amendment initiates the standards setting process envisioned when the cadmium variance was granted to Anaconda with the expectation that the variance will expire upon adoption of a new standard.

The revision of the cadmium standard from 0.0004 mg/l to 0.0012 mg/l is based upon a review of data supplied by Anaconda at stations D2 and D3 above the discharge point on the Dolores River. Consideration was also given to the existing table value for cadmium at the ambient hardness levels in the river, and the draft position on cadmium is being considered by the Basic Standards Task Force.

FISCAL IMPACT STATEMENT:

The costs of attaining a cadmium stream standard fall to the Anaconda Company at the present time since they are the sole point source discharger to the segment. A new treatment system was installed at the St. Louis pond site in February, 1984, and appears capable of producing an effluent of high enough quality to protect the stream standard during all flow seasons.

Other sources of cadmium enter the segment below Anaconda's discharge and account for a greater portion of mass loading to the segment than the permitted discharge. These sources are all classed as nonpoint and include mineralized groundwater, drainage from abandoned mines, and runoff through tailings. It is conceivable that costs for cadmium loading reduction could accrue to owners of these sources at such time that a nonpoint source control program were implemented. The necessary investment to meet the proposed standard has already been made by Anaconda and that portion of the costs attributable to cadmium removal cannot be measured since all metals will be reduced by the method of treatment used.

Benefits to attaining the amended standard accrue to all users of the stream and also to Anaconda in the form of relaxed discharge limitations over those based on the 0.0004 mg/l standard. The amended standard should protect the uses of the stream as fully as possible since it is no less stringent than the upstream ambient quality and is compatible with the elevated hardness levels found in the river at low flows.

3.4.11 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE; AUGUST, 1989 HEARING ON MULTIPLE SEGMENTS

The provisions of 25-8-202(1)(a), (b) and (2); 25-8-203; 25-8-204; 25-8-207 and 25-8-402 C.R.S. provide the specific statutory authority for adoption of these regulatory amendments. The Commission also adopted, in compliance with 24-4-103(4), C.R.S., the following statement of basis and purpose.

BASIS AND PURPOSE:

First, the Commission has adopted new introductory language for the tables, in section 3.4.6(2). The purpose of this language is to explain the new references to "table value standards" (TVS) that are contained in the Tables. The other changes considered and adopted are addressed below.

A. Jurisdiction on Tribal Lands

On the issue of classifying and setting standards on tribal lands, the Commission was advised to classify and set standards as they would for waters on non-tribal lands with the understanding that the Commission is not attempting to assert jurisdiction or to usurp the authority of the tribe to classify and set standards for waters within the boundaries of the reservation.

B. Table Value Standards for Metals

San Juan, Segment 7; Los Pinos, Segment 4; Animas, Segment 5; Dolores, Segments 5 and 7.

Numerical standards for metals for these segments have in most instances previously been based on table values contained in Table III of the Basic Standards and Methodologies for Surface Water. Table III has been substantially revised, effective September 30, 1988. A few of these segments had no new data to indicate that new table value standards are not appropriate. There are also some of these segments whose previous standards were based in part on ambient quality, since their quality did not meet old table values based on alkalinity ranges. However, these segments generally have much higher hardness than alkalinity, and the new table values (based on hardness-dependent equations) are now appropriate as standards.

C. New High Quality 2 Designations

San Juan, Segments 1, 5, and 9; Piedra, Segments 3 and 5; Los Pinos, Segment 2a; Animas, Segments 8a, 10, 11, 12a, 12b, and 14; La Plata, Segments 1 and 4; Dolores, Segments 4 and 10.

From the information available, it appears that the existing quality of these segments meets or exceeds the quality specified by the revised criteria in Table III, and new acute and chronic table value standards based thereon have therefore been adopted.

Second, in addition to these standards changes, the use classifications have been revised where necessary so that each of these segments has the following classifications:

Recreation - Class 1

Cold Water Aquatic Life - Class 1

Water Supply

Agriculture

D. Existing High Quality 2 Segments; New Classifications and Standards

San Juan, Segment 4; Piedra, Segments 1 and 2; Los Pinos, Segment 1; Animas and Florida, Segment 1; Dolores, Segment 1.

These segments were already described as High Quality Class 2, as all are wilderness and wild and scenic rivers. Available information indicates that the parallel new High Quality 2 designation continues to be appropriate for each, along with new table value numeric standards and equations for cold water aquatic life classifications, i.e., acute (trout) for cadmium and zinc and chronic (trout) for silver.

The following use classifications, and associated table value standards, have been adopted for these segments:

Recreation - Class 1

Cold Water Aquatic Life - Class 1

Water Supply

Agriculture

E. New Use-Protected Designations; No Change in Numeric Standards

San Juan, Segments 3, 10, and 11; Piedra, Segment 6; Los Pinos, Segment 6; Animas and Florida, Segments 3, 4, 9, 13b, and 15; La Plata, Mancos, McElmo, and San Juan, Segments 2, 3, 5, 6, 7, and 8; Dolores, Segments 9 and 11.

These segments all qualify for a Use-Protected designation based either on their present classifications or the existing standards contain three or more of the following metals parameters whose concentrations, based on total recoverable metals, indicate they may be worse than that specified in Table III for the protection of aquatic life class 1 use: cadmium, copper, iron, lead, or zinc.

F. New Use-Protected Designation; Table Value Standards

Piedra, Segment 7; Animas and Florida, Segment 13a.

These segments qualify for a Use-Protected designation based upon their classification. Previous standards were based on table values and no new data was presented to indicate new table value standards are not appropriate.

For these segments, acute and chronic table value standards have been adopted for arsenic, cadmium, chromium (III and IV), copper, iron, lead, manganese, mercury, nickel, selenium, silver, and zinc.

G. Revised Recreation Classification

San Juan, Segments 2 and 6; Piedra, Segment 4; Los Pinos, Segment 2b; La Plata, Segment 9

The recreation classification on these segments has been upgraded from Class 2 to Class 1 (whole body immersion is likely) because the stream sampling data indicate that the fecal coliform standard 200/100 ml is not being exceeded, and conditions are normally considered suitable for swimming or intentional whole body contact. This action was taken in response to a concern raised by the EPA regarding segments not attaining "fishable/swimmable" uses.

H. Other Revisions

1. Los Pinos, Segments 3 and 5.

Based on stream sampling data for Segment 3, table value standards were established as were ambient standards for cadmium and lead. For Segment 5, ambient standards for cadmium and lead were added; table value standards were added for the remaining metals.

2. San Juan, Segment 9 (Four Corners Area)

Table Value Standards for metals have been adopted for this segment with the exception of total recoverable iron whose 50 percentile value is 2200 ug/l. In addition, the recreation classification has been changed from Class 2 to Class 1 with a fecal coliform standard of 200/100 ml.

0486m/0025m/
10/89 Rev.

PARTY STATUS LIST
OF
PUBLIC RULEMAKING HEARING
AUGUST 7, 1989

For consideration of adoption of amendments to the regulations for the San Juan River Basin, 3.4.0 (5 CCR 1002-8)

NAME	REPRESENTED BY	MAILING ADDRESS	TELEPHONE
1. The Southwestern Water Conservation District, "District"	Richard L. Sisk	Maynes, Bradford & Shipps P.O. Box 2717 1060 Main Avenue, Suite 103 Durango, Colorado 81302-2717	303-247-1755
2. The San Juan County Mining Venture	William C. Robb	Welborn, Dufford, Brown & Tooley, P.C. Suite 1700 1700 Broadway Denver, Colorado 80290-1701	303-861-8013
3. The Pagosa Area Water and Sanitation District, "District"	James P. Collins	Collins & Cockrel, P.C. 390 Union Blvd. Lakewood, Colorado 80228	303-986-1551
	Timothy J. Beaton	1507 Pine Street Boulder, Colorado 80302	303-447-0028

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0332m/0023m

3.4.12 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE; FEBRUARY, 1990 EMERGENCY RULEMAKING HEARING

The provisions of 25-8-208 and 25-8-402 (5) C.R.S. provide the specific statutory authority for action on these regulatory amendments

BASIS AND PURPOSE:

The Commission held this emergency rulemaking hearing to readopt the classifications and numeric standards for the San Juan River and Dolores River Basins to correct errors in the original filing. The affected regulation was amended on November 7, 1989 and was filed within the required timeframes with the Secretary of State's Office and the Office of Legislative Legal Services. The Commission learned shortly after the filings that three (3) pages had been inadvertently left out of the regulation, and that a typographical error appeared throughout the classification and standards tables that are part of the regulation. The Commission office was able to correct the errors with a replacement filing with the Secretary of State's Office so that the regulation published in the CCR (Colorado Code of Regulation) correctly reflects the Commission's actions.

The Office of Legislative Legal Services notified the Commission that it could not accept the corrected materials as they had not been submitted within the 20 day timeframe called for in section 24-4-103 (8) (d), C.R.S. of the "State Administrative Procedure Act". It was suggested that the Commission needed to repromulgate the rules that contained the errors submitted in November, 1989 and resubmit them.

The Commission elected to proceed on an emergency rulemaking basis to avoid any confusion that could result due to the fact that the two filings are currently not the same. Therefore, the Commission adopted the corrected version of the regulation at an emergency rulemaking hearing on February 6, 1990. Final action on the readoption is scheduled for June 5, 1990.

1776m/0184m/cmc

3.4.12 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE; JUNE, 1990 RULEMAKING HEARING

The provisions of 25-8-202(1)(a), (b) and (2); 25-8-203; 25-8-204; 25-8-207 and 25-8-402 C.R.S. provide the specific statutory authority for action on these regulatory amendments.

BASIS AND PURPOSE:

The Commission held this rulemaking hearing to make permanant the emergency hearing that was held in February, 1990 to readopt the classifications and numeric standards for the San Juan River and Dolores River Basins to correct errors in the original filing. The affected regulation was amended on November 7, 1989 and was filed within the required timeframes with the Secretary of State's Office and the Office of Legislative Legal Services. The Commission learned shortly after the filings that three (3) pages had been inadvertently left out of the regulation, and that a typographical error appeared throughout the classification and standards tables that are part of the regulation. The Commission office was able to correct the errors with a replacement filing with the Secretary of State's Office so that the regulation published in the CCR (Colorado Code of Regulation) correctly reflects the Commission's actions.

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The Commission elected to proceed on an emergency rulemaking basis to avoid any confusion that could result due to the fact that the two filings are currently not the same. Therefore, the Commission adopted the corrected version of the regulation at an emergency rulemaking hearing on February 6, 1990.

1776m/0184m/cmc

3.4.13 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE; MARCH 1, 1993 HEARING:

The provisions of 25-8-202(1)(a), (b) and (2); 25-8-203; 25-8-204; and 25-8-402 C.R.S. provide the specific statutory authority for adoption of these regulatory amendments. The Commission also adopted in compliance with 24-4-103(4), C.R.S., the following statement of basis and purpose.

BASIS AND PURPOSE:

The changes to the designation column eliminating the old High Quality 1 and 2 (HQ1, HQ2) designations, and replacing HQ1 with Outstanding Waters (OW) designation were made to reflect the new mandates of section 25-8-209 of the Colorado Water Quality Act which was amended by HB 92-1200. The Commission believes that the immediate adoption of these changes and the proposals contained in the hearing notice is preferable to the alternative of waiting to adopt them in the individual basin hearings over the next three years. Adoption now should remove any potential for misinterpretation of the classifications and standards in the interim.

In addition, the Commission made the following minor revisions to all basin segments to conform them to the most recent regulatory changes:

1. The glossary of abbreviations and symbols were out of date and have been replaced by an updated version in section 3.4.6(2).

2. The organic standards in the Basic Standards were amended in October, 1991, which was subsequent to the basin hearings. The existing table was based on pre-1991 organic standards and are out of date and no longer relevant. Deleting the existing table and referencing the Basic Standards will eliminate any confusion as to which standards are applicable.

3. The table value for ammonia and zinc in the Basic Standards was revised in October, 1991. The change to the latest table value will bring a consistency between the tables in the basin standards and Basic Standards.

4. The addition of acute un-ionized ammonia is meant to bring a consistency with all other standards that have both the acute and chronic values listed. The change in the chlorine standard is based on the adoption of new acute and chronic chlorine criteria in the Basic Standards in October, 1991.

Finally, the Commission confirms that in no case will any of the minor update changes described above change or override any segment-specific water quality standards.

3.4.14 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE, SEPTEMBER 7, 1993:

The provisions of 25-8-202(1)(a), (b) and (2); 25-8-203; 25-8-204; and 25-8-402 C.R.S. provide the specific statutory authority for adoption of these regulatory amendments. The Commission also adopted in compliance with 24-4-103(4), C.R.S., the following statement of basis and purpose.

BASIS AND PURPOSE:

On November 30, 1991, revisions to "The Basic Standards and Methodologies for Surface Water",. 3.1.0 (5 CCR 1002-8), became effective. As part of the revisions, the averaging period for the selenium criterion to be applied as a standard to a drinking water supply classification was changed from a 1-day to a 30-day duration. The site-specific standards for selenium on drinking water supply segments were to be changed at the time of rulemaking for the particular basin. Only one river basin, the South Platte, has gone through basin-wide rulemaking since these revisions to the "Basic Standards". Through an oversight, the selenium standards was not addressed in the rulemaking for this basin and has since become an issue in a wasteload allocation being developed for segments 15 and 16 of the South Platte. Agreement on the wasteloads for selenium is dependent upon a 30-day averaging period for selenium limits in the effected parties permits. Therefore, the parties requested that a rulemaking hearing be held for the South Platte Basin to address changing the designation of the 10 ug/l selenium standard on all water supply segments from a 1-day to a 30-day standard. The Water Quality Control Division, foreseeing the possibility of a selenium issue arising elsewhere in the state, made a counter proposal to have one hearing to change the designation for the selenium standard on all water supply segments statewide. The Commission and the parties concerned with South Platte segments 15 and 16 agreed that this would be the most judicious way to address the issue.

The change in the averaging period may cause a slight increase in selenium loads to those segments which have CPDS permits regulating selenium on the basis of a water supply standard. However, these segments are only five in number and the use will still be fully protected on the basis that the selenium criterion is based on 1975 national interim primary drinking water regulations which assumed selenium to be a potential carcinogen. It has since been categorized as a non-carcinogen and new national primary drinking water regulations were promulgated in 1991 that raised the standard to 50 ug/l.

The Commission also corrected a type error in the TVS for Silver by changing the sign on the exponent for the chronic standard for Trout from + 10.51 to - 10.51.

4H

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY.

CHARLES D. WALCOTT, DIRECTOR

GEOLOGIC ATLAS

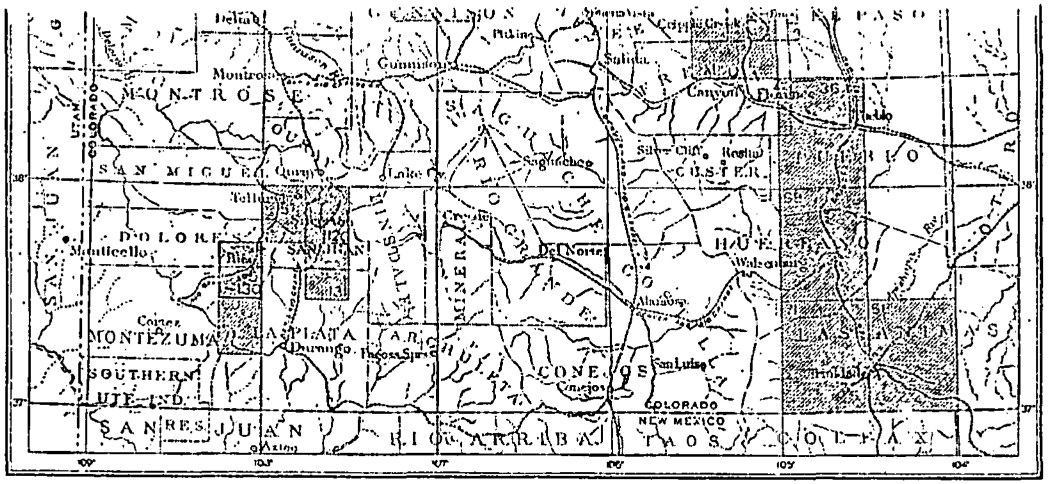
OF THE

UNITED STATES

RICO FOLIO

COLORADO

INDEX MAP



SCALE: 40 MILES = 1 INCH

RICO FOLIO

OTHER PUBLISHED FOLIOS

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COLUMNAR SECTION SHEET
ILLUSTRATION SHEET

Folio 130

WASHINGTON, D. C.
ENGRAVED AND PRINTED BY THE U. S. GEOLOGICAL SURVEY
GEORGE W. STOSE, EDITOR OF GEOLOGIC MAPS. S. J. KUBEL, CHIEF ENGRAVER
1905

DESCRIPTION OF THE RICO

By Whitman Cross and F. L. Ransome.

GEOGRAPHY AND GENERAL GEOLOGY OF

By Whitman Cross.

INTRODUCTION.

The Rico quadrangle is situated in southwestern Colorado, about 50 miles west of the Continental Divide, in the zone bordering the San Juan Mountains, almost at the head of the Dolores River. It is bounded by meridians 108° and 108° 15′ west longitude and parallels 37° 30′ and 37° 45′ north latitude, embracing about 236 square miles.

GENERAL RELATIONS OF THE QUADRANGLE.

Relations to the plateau country.—The Rico quadrangle lies in the north-south zone that marks the eastern border of a very notable plateau surface which covers the greater part of the area between the Colorado River in Utah and the San Juan Mountains of Colorado. Below the gently undulating surface of this plateau many canyons have been carved by streams, one of the principal gorges being that of the Dolores River. Entering its canyon valley within the Rico quadrangle this stream flows with irregular course for about 18 miles in a southwesterly direction and then swings to a general north-northwest trend, which it maintains for over 100 miles to the Grand River.

The larger part of the plateau surface lying between the Dolores and Colorado rivers is called the Great Sage Plain, while its direct continuation eastward and toward the head of the Dolores is named the Dolores Plateau.

This broad plain surface is due chiefly to a heavy sandstone, the Dakota (Cretaceous), and its undulations are in part structural, in harmony with the slightly varying dips of the sandstone, and in part owing to remnants of the soft, thick shale formation normally overlying the sandstone. The Great Sage Plain of Utah has a general elevation of 6000 to 7000 feet above the sea. Eastward the Dolores Plateau gradually rises with the dip of the sandstone until, on the western border of the Rico quadrangle, it has an altitude of over 9000 feet. Beyond that line it rises more rapidly as the Dakota sandstone and other formations take part in the local structures of the Rico and La Plata Mountains, to be described in detail.

Relations to the San Juan Mountains.—The southwestern front of the volcanic San Juan Mountains lies 6 to 8 miles northeast of the Rico quadrangle. The intervening space is characterized by irregular foothill topography, with features due in part to the upturning and erosion of various sedimentary formations about the ancient San Juan center of uplift and in part to large masses of intrusive igneous rocks. These intrusions are similar in character to those of the Rico Mountains.

No surface volcanic rocks of the San Juan succession occur in the Rico quadrangle. It is probable, however, that the San Juan volcanics once extended over this area and have been removed by erosion. In support of this idea may be mentioned the fact that only a few miles north of the Rico area, on the south slopes of the San Miguel Mountains, a line of high peaks which are geologically as well as topographically western outliers of the San Juan Mountains, remnants of the horizontal

Features of the Rico Mountains.—The small group of mountains in the northeastern section of the quadrangle is in large degree a local center of uplift which is apparently independent of igneous intrusion; but it is also to an important extent characterized by many injected laccolithic masses. The intrusive rocks are of kinds common in the so-called laccolithic mountain groups of the plateau country, embracing the La Plata, El Late, Carriso, Abajo, La Sal, and Henry mountains, most of which are plainly visible from the Rico summits. This character of the Rico group was not recognized during the Hayden Survey.

The sedimentary section.—In general the section of sedimentary formations exposed in the valley of the Dolores River is that normal to the zone about the San Juan Mountains. It is, for example, like that shown in the adjoining Telluride quadrangle by the erosion of the San Miguel River, and extends from the Mancos (Cretaceous) shales down into the Carboniferous red beds. But in consequence of the Rico uplift and its bisection by the Dolores the lower Paleozoic formations are shown locally, and even certain quartzites of the Algonkian. The formations thus revealed in the Dolores Valley have the general character of the complete section more perfectly exposed in the Animas Valley, about 12 miles to the east. The Mesozoic formations are the same that characterize the canyons of the plateau country to the west, but it is known that most of those formations exhibit progressive changes as distance from the Colorado mountain area increases. These changes have not yet been examined in detail.

GEOGRAPHY AND TOPOGRAPHY OF THE QUADRANGLE.

The Rico quadrangle presents three especially prominent types of topographic forms, each dominating a considerable part of the area. These notable features are (1) the Dolores Plateau, (2) the Rico Mountains, and (3) the Dolores Valley, with its many lateral branches.

The Dolores Plateau.—The western half of the Rico quadrangle belongs to the Dolores Plateau. A glance at the topographic map shows that between the Dolores River and Stoner Creek there is a gently inclined mesa crossed by the western meridian of the quadrangle at an elevation of about 9400 feet. The flat crest of the narrow ridge between Stoner Creek and the West Dolores is clearly a remnant of the same plateau level and on the northern line of the quadrangle it appears again.

South of the Dolores the same notable mesa feature may be recognized. The actual extent of the mesa surface in the quadrangle may be most clearly appreciated by an examination of the geological map, where its outline is shown by means of the mapping of the distribution of the Dakota sandstone, its floor. The mesa remnants are bounded by distinct scarps formed by the sandstone.

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The plateau feature gradually disappears as its sandstone floor comes under the influence of the local domal uplifts of the Rico and La Plata mountains. The contours of the map clearly express the changing dip of the Dakota sandstone, and with it the changing slope of the mesa surface itself as those mountains are approached. West of the Rico Mountains the dip slope of the mesa reaches an elevation of 11,500 feet on the ridge west of Eagle Peak. This corresponds closely to the level attained by the similar plane on the east side of Bear Creek, north of the La Plata Mountains, for across the southern part of

THE RICO QUADRANGLE.

Whitman Cross and F. L. Ransome.

:RAL GEOLOGY OF THE QUADRANGLE.

By Whitman Cross.

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Almost the entire surface of these mesa or plateau remnants is covered by a forest growth in which white pine and aspen are the chief elements. The mesa border southwest of Bear Creek is especially characterized by a magnificent growth of stately aspens. At lower levels piñon, white pine, cedar, and scrub oak become more and more prominent.

The Rico Mountains.—The summits of this compact and rather isolated group lie within an oval area about 7 miles in diameter from east to west and 5 miles from north to south. The peaks are nearly all included within the northeast section of the Rico quadrangle, but a few lie east of the one hundred and eighth meridian, in the Engineer Mountain quadrangle.

The topographic map of the quadrangle shows the general character of the mountains as compared with the plateau area and the long lateral ridges of the Dolores Valley. The special sheet exhibits the finer details of form and includes the peaks situated east of the quadrangle line.

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F. M. Endlich examined the district to the east, the one hundred and eighth meridian, passing through Telescope Mountain, being apparently the general western boundary of his field of work. In 1876 W. H. Holmes made a rapid reconnaissance over the plateau country to the west. The complicated geology of the Rico uplift, coming on the border zone between the fields of different men working in different seasons, did not receive adequate attention, and the Hayden map of this area is, therefore, quite unsatisfactory.

J. B. Farish and T. A. Rickard.—The only geological explorations of the quadrangle since the time of the Hayden Survey have been connected with mining developments in the Rico Mountains. In the course of descriptions of some of the mining properties near Rico there have been brief discussions of the geology of the mountain group. These discussions were for the most part founded on observations near and in the mines of Newman Hill. In 1892 John B. Farish read a paper before the Colorado Scientific Society entitled "On the Ore Deposits of Newman Hill, near Rico, Colorado" (Proc. Colorado Sci. Soc., vol. 4, pp. 151–164). The description of the ore deposits was preceded by some general remarks on the geology. The structure of the mountains was recognized by Farish as a domal uplift.

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The characteristic forms of peaks and gulches are illustrated in the photographs reproduced in this folio. Fig. 1 in particular shows the details of form commonly present in the higher summits on the eastern side of the river.

Timber line in the Rico Mountains lies between 11,500 and 12,000 feet, and its course may be traced in several of the illustrations of the folio.

The Dolores Valley.—The Dolores River has carved its valley through the heart of the Rico Mountains, and near the western boundary of the quadrangle it enters a canyon, cut far below the plateau level, in which it flows to its junction with the Grand River. The branches of the main stream within the area are all short, except Bear Creek, which heads a few miles to the south in the La Plata Mountains. The West Dolores Valley is nearly as large as the main fork, but lies wholly within the plateau region. The extreme head of the Dolores is at the northeast base of the Rico Mountains.

The canyons of the Dolores River, Lost Canyon, Stoner Creek, and the West Dolores are characteristic of the drainage channels of the plateau country. The sides are steep and are modified by many minor scarps representing resistant sandstone strata.

GEOLOGICAL INVESTIGATION OF THE REGION.

The Hayden Survey.—The country adjacent to Rico was visited by geologists of the Hayden Survey in 1874 and 1876. In the former year F. M. Endlich examined the district to the east, the one hundred and eighth meridian, passing through Telescope Mountain, being apparently the general western boundary of his field of work. In 1876 W. H. Holmes made a rapid reconnaissance over the plateau country to the west. The complicated geology of the Rico uplift, coming on the border zone between the fields of different men working in different seasons, did not receive adequate attention, and the Hayden map of this area is, therefore, quite unsatisfactory.

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U. S. Geological Survey.—In the course of the present resurvey of the Rico quadrangle the geologic complications in the Rico Mountains were found to be so great that a detailed topographic map and a special report on its geology and mineral resources were found necessary. This report appeared in the Twenty-first Annual Report of the Geological Survey under the title, "Geology of the Rico Mountains, Colorado," by Whitman Cross and Arthur Coe Spencer. As the Rico Mountains are the most important and most complex part of the quadrangle the text of this folio is in large degree descriptive of the phenomena exhibited in the mountains. But as only the broader features of the geology can be treated in this place the reader will often be referred for details to the publication just cited, which will be called in general terms "the Rico report." The special map of that report is republished in this folio as the economic sheet.

A report on the ore deposits of the Rico Mountains, by Frederick Leslie Ransome, appeared in the Twenty-second Annual Report of the Geological Survey, Part II, pp. 229–397. A summary of that report constitutes the section of this folio on "Economic geology."

Folios presenting the geology of the Telluride quadrangle on the northeast and of the La Plata quadrangle on the south have been issued. Those of the Engineer Mountain and Durango quadrangles, respectively east and southeast of the Rico, are in preparation.

CULTURE.

The agricultural development within the Rico quadrangle is limited to small areas of bottom land, principally in the valley of the West Dolores and to a less extent in that of the main river. The level expanses of the plateau are not available for cultivation, because of the lack of water. They afford excellent grazing land in many places.

Metalliferous deposits in the Rico Mountains have led to extensive mining operations and the foundation of the town of Rico, situated on the river in the heart of the mountain group. The Rio Grande Southern Railroad crosses the quadrangle, following the valley of the Dolores River.

DESCRIPTIVE GEOLOGY.

THE ROCK FORMATIONS.

SEDIMENTARY AND METAMORPHIC ROCKS.

ALGONKIAN SYSTEM.

Algonkian = Late Precambrian

Introductory statement.—The rocks which are described as Algonkian occupy a small area in the center of the Rico Mountains, where they have been exposed by the carving of the Dolores Valley through the heart of the uplift. They comprise quartzites and quartzitic schists and are similar to the series of rocks exposed in the Uncompahgre Canyon on the north side of the San Juan Mountains and in the Needle Mountains on the south side of the San Juan. In the latter region they were represented on the Hayden map as "metamorphic Paleozoic."

The quartzites of the Animas Canyon section through the Needle Mountains have been examined by Emmons and Van Hise, who have assigned them to the Algonkian system. The correctness of this assignment is confirmed by recent work of the Geological Survey in the Needle Mountains and the discovery of Cambrian fossils in the lowest Paleozoic formation of that area, which rests unconformably on the quartzites and other pre-Cambrian rocks. In the Silverton folio the quartzites, slates, and conglomerates of this ancient complex were called the Uncompahgre formation. The Uncompahgre quartzites and slates are underlain in the Needle Mountains by a thick conglomerate called the Vallecito formation. The Vallecito and the Uncompahgre together constitute the Needle Mountains group, according to the nomenclature proposed in the Needle Mountains folio.

UNCOMPAHGRE FORMATION.

Character.—The Algonkian rocks, very imperfectly exposed at Rico, consist of quartzites and quartzitic schists bearing small amounts of mica. The quartzites are found only in the valley of Silver Creek, in small upthrust fault blocks, and are not distinguishable in character from other massive quartzites, to be described later, which are supposed to be of Cambrian age; but the visible thickness and the structural attitude of the Algonkian rocks make it impossible to refer them to the thin Cambrian formation of this region. They are white or tinged with brown, with occasional red or rusty bands. They are composed almost entirely of quartz, occurring usually in small, even-grained particles, but sometimes in the form of pebbles less than an inch in diameter. The rock is completely indurated by the interstitial deposition of quartz, so that it is now glassy quartzite, very resistant to erosion. Distinct partings between the beds of quartzite are nowhere observable in present exposures. However, the bedding or stratification planes may frequently be made out from a study of the massive quartzites, where differences of grain are found or where cross-bedding is observable. Ripple-marked surfaces are also occasionally seen.

Occurrence.—There are six separate areas of quartzite in the valley of Silver Creek, and of these one, that below Allyn Gulch, is certainly Algonkian, as must be inferred from its great mass; another, on the opposite side of Silver Creek, is probably of that age; while the others have been assigned to the Paleozoic. In the place first mentioned the ... elevations of 9200 and 9500 feet, showing a continuous exposure at one place to a thickness of 350 feet, though from the structure it is probable that a greater thickness is present. The strike and dip may be determined in this region and, while both are variable, the former is generally about N. 10°-30° E. and the latter is steeply toward the south of east. On the north, south, and west the boundaries of this mass of quartzite are not known, since they are covered by surface débris; but from the adjacent occurrences of porphyry belonging to the thick sill of Newman Hill it is almost certain that the quartzite is limited on the south and west by faults, in the manner indicated on the map, while on the north it may connect underneath the valley wash with the quartzite on the north side of Silver Creek.

Within the area just mentioned the rocks are very imperfectly exposed, except in local patches, but from these and from the data derived from tunnels and prospects it is definitely known that the northern limit is along the Last Chance fault, which has a nearly east-west course. The highest exposures are near this fault, at about 9400 feet, and the quartzite can not extend much beyond this point, since green shales and sandstones are exposed at about the same elevation in the draw below the Alma Mater mine.

SCHIST.

Character.—The remaining rocks of probable Algonkian age may be termed schists, since they have a more or less distinct foliated structure, not due to original bedding, but superinduced by metamorphism under stress. In these schists the stratification may be made out in some cases by differences in the character of adjacent bands, and to this structure the foliation is generally, though not always, parallel. The direction of foliation does not vary greatly from east and west, and its position is nearly vertical wherever observed.

The schists are dense bluish-gray rocks, the foliation being caused by the arrangement of very minute particles of biotite and actinolite, not recognizable to the unaided eye. A delicate luster is visible on the planes of easier fracture, but the schistosity is never very highly developed and the rocks often break readily across the structure with almost conchoidal fracture.

In a few places the rock has quite clearly the character of a mashed product, apparently derived from a porphyry in which there were phenocrysts of quartz and feldspar. There is a slight development of tourmaline in such rocks.

Intruded into these schists, in general parallel to the structure, but sometimes crosscutting, are many thin dikes of a dark porphyritic rock. These are prominent on both sides of the river, but have not been found in the Algonkian quartzites nor in any other rock than the schists; hence they are supposed to be very old intrusions, independent of the other eruptions of the region. This idea is substantiated by the mashing of some of the dikes. Stout prisms of hornblende are the only prominent crystals of the rock. There is also much secondary hornblende and epidote revealed by the microscope. The former, subordinate feldspathic constituent is so much crushed and altered that the original character can not be determined. Plagioclase was probably predominant over orthoclase.

Occurrence.—The Algonkian schists occur only in the Dolores Valley just above Rico in small upthrust fault blocks, and the structure about them is so complicated, as shown by the special sheet, that the relations of the schists to the Algonkian quartzites and of the latter to small areas of Paleozoic quartzites have not been satisfactorily demonstrated in all cases.

CAMBRIAN (?) SYSTEM.

IGNACIO QUARTZITE.

Introductory statement.—The lowest member of the Paleozoic section displayed in the Rico Mountains is a quartzite which was grouped with the overlying limestone in the Rico report, both being referred to the Devonian, though with a reserva-

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quartzites and the Devonian
intermediate formation consist-
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Occurrence.—The most clearly
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DEVONO-CARBONIFEROUS R

OURAY LIMESTONE.

Name and definition.—The pres
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mation deserving recognition occurs between the quartzites and the Devonian limestone. This intermediate formation consists, as known in the Animas Valley, of thin-bedded limestones and calcareous shales with varying amounts of thin quartzites, the whole less than 100 feet in thickness. Fragments of fish scales and bones have been found in these beds and although but a few specifically determinable forms have yet been obtained, it is considered probable by Dr. C. R. Eastman, who has studied them, that these fossils are identical or closely related to fish remains occurring in the Catskill formation of the upper Devonian, in Pennsylvania. In the Silverton folio the fish-bearing series of beds was named the Elbert formation. The observations made at Rico do not indicate the presence of the Elbert beds at that locality, but it is possible that the limited exposures and the more or less metamorphosed condition of the rocks may have hindered recognition of the characteristic features of this formation.

The lowest lithologic division of the Paleozoic section in the Animas Valley is made up of quartzites, and varies in thickness from a few feet up to 200 feet. A single fossil shell, determined by Charles D. Walcott as *Obolus* sp.? and resembling certain Upper Cambrian species, has been found in these quartzites, and therefore it seems at present best to refer the formation to the upper or Saratogan series of the Cambrian. In the Silverton folio this was named the Ignacio formation, from its occurrence near the Ignacio Lakes in the Engineer Mountain quadrangle.

The Ignacio beds at Rico.—The quartzites here provisionally referred to the Ignacio formation may be seen in the bed of the Dolores River just above Rico and along the west bank of the stream. These strata dip at an angle of a few degrees southward, passing under the mineralized limestone of the Atlantic Cable claim. They were encountered beneath that limestone in the bore hole sunk on the claim mentioned. It is probable that the quartzites reach a thickness of at least 200 feet.

This basal quartzite is a massive rock, very dense and highly indurated. Its colors are dull yellow-white with red and brown stains. There is a slight variation in grain, the mass of the formation being fairly homogeneous. The stratification is sometimes discernible, though usually obscured by jointing and rifting. The formation is not clearly distinguishable from the Algonkian quartzite except by its more regular bedding and by the conformable attitude which it bears to the overlying Paleozoic rocks.

Occurrence.—The most clearly defined quartz-...

of Devonian age. It was supposed by Spence... that the whole limestone complex in question mu... be of Devonian age, but as will be shown, it ha... been proved that an indefinite but subordinate pa... of the most prominent limestone ledge of th... Ouray is Mississippian. Since it is impossible to draw a line between the two portions, the Ouray becomes a lithologic unit transgressing the faunal boundary between the Devonian and Carbonifer-ous systems.

General lithologic character.—The Ouray formation as at present known has a thickness vary-ing from 100 to 300 feet. The upper and major part of the formation is massive limestone, either in one bed or with such thin intercalated shale that the ability of the limestone to resist erosion and thus to cause mesas, benches, and prominent cliffs as characteristic topographic forms, is always notable. Below the more massive portion a third or less of the section is made of well-bedded limestone with distinct shaly layers and, rarely, thin quartzites, between them. Some of the lower layers have a wavy bedding, some are arenaceous or earthy, and large chert concretions, free from fossils, are common at a horizon near the base. The lowest stratum is characterized usually by crinoid stems and rarely a cup coral.

The greater part of the formation is dense, compact limestone, but portions of the upper ledge are coarsely crystalline. In general, the rock is nearly white, straw yellow, or buff, with local pinkish tones. Some of the lower beds are strongly yellow and these are commonly more or less sandy. The contrast with the dark-gray, dense limestone of the Hermosa is marked, layers of such character occurring only near the base of the Ouray.

The Carboniferous portion of the Ouray is lithologically indistinguishable from the Devonian.

Faunas and correlation.—The Devonian invertebrate fauna of the Ouray occurs from near the base to a horizon which in many places is not far below the top of the upper, massive ledge. The greater number of species occur in this upper horizon, but many of them range to within a few feet of the base.

The Mississippian fauna has been found at several localities in the Animas Valley in coarsely crystalline beds near the top of the formation.

Fossils have not been found at Rico, but have been obtained at Ouray and at several localities on the southern slope of the San Juan, including that where Endlich first found a few characteristic Devonian species.

The invertebrate fauna of the Devonian portion of the Ouray has been fully described by G. H. ...

ormably on the quartzites and other pre-Cambrian rocks. In the Silverton folio the quartzites, slates, and conglomerates of this ancient complex were called the Uncompahgre formation. The Uncompahgre quartzites and slates are underlain in the Needle Mountains by a thick conglomerate called the Vallecito formation. The Vallecito and the Uncompahgre together constitute the Needle Mountains group, according to the nomenclature proposed in the Needle Mountains folio.

UNCOMPAHGRE FORMATION.

Character.—The Algonkian rocks, very imperfectly exposed at Rico, consist of quartzites and quartzitic schists bearing small amounts of mica. The quartzites are found only in the valley of Silver Creek, in small upthrust fault blocks, and are not distinguishable in character from other massive quartzites, to be described later, which are supposed to be of Cambrian age; but the visible thickness and the structural attitude of the Algonkian rocks make it impossible to refer them to the thin Cambrian formation of this region. They are white or tinged with brown, with occasional red or rusty bands. They are composed almost entirely of quartz, occurring usually in small, even-grained particles, but sometimes in the form of pebbles less than an inch in diameter. The rock is completely indurated by the interstitial deposition of quartz, so that it is now glassy quartzite, very resistant to erosion. Distinct partings between the beds of quartzite are nowhere observable in present exposures. However, the bedding or stratification planes may frequently be made out from a study of the massive quartzites, where differences of grain are found or where cross-bedding is observable. Ripple-marked surfaces are also occasionally seen.

Occurrence.—There are six separate areas of quartzite in the valley of Silver Creek, and of these one, that below Allyn Gulch, is certainly Algonkian, as must be inferred from its great mass; another, on the opposite side of Silver Creek, is probably of that age; while the others have been assigned to the Paleozoic. In the place first mentioned the quartzites have their greatest development. They are bounded on the east by a well-marked fault, shown in the Laxy mine; thence toward the southwest they may be traced for a quarter of a mile along the hillside, on the slope of which their outcrops are to be seen between the ation being caused by the arrangement of very minute particles of biotite and actinolite, not recognizable to the unaided eye. A delicate luster is visible on the planes of easier fracture, but the schistosity is never very highly developed and the rocks often break readily across the structure with almost conchoidal fracture.

In a few places the rock has quite clearly the character of a mashed product, apparently derived from a porphyry in which there were phenocrysts of quartz and feldspar. There is a slight development of tourmaline in such rocks.

Intruded into these schists, in general parallel to the structure, but sometimes crosscutting, are many thin dikes of a dark porphyritic rock. These are prominent on both sides of the river, but have not been found in the Algonkian quartzites nor in any other rock than the schists; hence they are supposed to be very old intrusions, independent of the other eruptions of the region. This idea is substantiated by the mashing of some of the dikes. Stout prisms of hornblende are the only prominent crystals of the rock. There is also much secondary hornblende and epidote revealed by the microscope. The former subordinate feldspathic constituent is so much crushed and altered that the original character can not be determined. Plagioclase was probably predominant over orthoclase.

Occurrence.—The Algonkian schists occur only in the Dolores Valley just above Rico in small upthrust fault blocks, and the structure about them is so complicated, as shown by the special sheet, that the relations of the schists to the Algonkian quartzites and of the latter to small areas of Paleozoic quartzites have not been satisfactorily demonstrated in all cases.

CAMBRIAN (?) SYSTEM.

IGNACIO QUARTZITE.

Introductory statement.—The lowest member of the Paleozoic section displayed in the Rico Mountains is a quartzite which was grouped with the overlying limestone in the Rico report, both being referred to the Devonian, though with a reservation as to the quartzite, since it was recognized that that formation might be much older than the limestone. Recent investigations in the quadrangles lying east of the Rico have shown not only that the quartzites are probably of Saratogan (Upper Cambrian) age, but that another thin for- quartzites with a thickness of at least 200 feet.

This basal quartzite is a massive rock, very dense and highly indurated. Its colors are dull yellow-white with red and brown stains. There is a slight variation in grain, the mass of the formation being fairly homogeneous. The stratification is sometimes discernible, though usually obscured by jointing and rifting. The formation is not clearly distinguishable from the Algonkian quartzite except by its more regular bedding and by the conformable attitude which it bears to the overlying Paleozoic rocks.

Occurrence.—The most clearly defined quartzites of the Ignacio formation occur in the valley of the Dolores River, just north of Rico and south of the Smelter fault. Certain other quartzites, which are associated with Algonkian schists on both sides of the river near the Last Chance fault, have also been referred to this formation. Still other quartzites, mapped as Devonian on the special map accompanying the Rico report, occur in the valley of Silver Creek. These quartzites seem to occur in conformity with the Carboniferous rocks of Newman Hill. If they are Cambrian, however, the absence of the Devonian limestone above them must be explained. In the Rico report, to which the reader must be referred for further discussion of this question, it was assumed that the Devonian limestone had been removed by erosion at this point before the deposition of the Hermosa (Carboniferous).

DEVONO-CARBONIFEROUS ROCKS.

OURAY LIMESTONE.

Name and definition.—The presence of Devonian strata in southwestern Colorado was first recognized in 1874, through collections of fossils made by F. M. Endlich, of the Hayden Survey, on the southern slopes of the Needle Mountains. The name Ouray limestone was proposed by A. C. Spencer, in 1900, after the strata had been reexamined in connection with the U. S. Geological Survey work, from the town of Ouray, on the southern border of which is a prominent outcrop of the limestone.

The name was proposed by Spencer for the Devonian limestone member of the pre-Carboniferous Paleozoic, excluding the quartzites and shales here called the Ignacio and Elbert formations, although they were thought to be possibly greater number of species occur at the upper horizon, but many of them range to within a few feet of the base.

The Mississippian fauna has been found at several localities in the Animas Valley in coarsely crystalline beds near the top of the formation.

Fossils have not been found at Rico, but have been obtained at Ouray and at several localities on the southern slope of the San Juan, including that where Endlich first found a few characteristic Devonian species.

The invertebrate fauna of the Devonian portion of the Ouray has been fully described by G. H. Girty, and compared with similar faunas hitherto collected in Colorado, but not recognized as distinct from the forms of the Mississippian. It is represented more or less fully in older collections from the Elk Mountains, at Glenwood Springs on Grand River, near the head of White River, and on East Monarch Mountain, Chaffee County. Full correlations of the sections in these localities with that of the San Juan region can not be made, however, until further examinations have been carried out. Concerning the fauna Mr. Girty writes:

In general the Devonian fauna of the Ouray belongs to late middle or, more probably, to upper Devonian time. It is but distantly related to the Devonian faunas of New York, and its relation with those of the Mississippi Valley, or even with other known western Devonian faunas, is not close. It shows many points of approximation to the Athabascan fauna described by Whiteaves, and is somewhat strikingly similar to the Devonian of Russia.

The following named species are particularly characteristic of the Devonian portion of the Ouray fauna:

Schuchertella Chemungensis	Camarotœchia Endlichi.
Productella semiglobosa.	Camarotœchia contracta?
Athyris Coloradoensis.	Naticopsis? humilis.
Spirifer engelmanni.	Orthoceras sp.
Spirifer disjunctus var. Animasensis.	

As to the Mississippian fauna of the Ouray limestone Mr. Girty makes the following statement:

The fauna which at one time occupied the higher beds of the Ouray limestone is very different from the assemblage of Devonian types which occurs below, and belongs to a phase of Carboniferous life which was widely distributed over the continental sea. It is found in the cases the preservation of the mountains as regions of high topographic relief is due to the presence *of igneous rocks which have been more resistant* to erosion than the sediments would have been alone. The intrusions are in the form of stocks, dikes, and sheets. To the latter, which may in some cases have sufficient thickness to be of the type known as laccoliths, a certain amount of the observed *deformation* of the stratified rocks is certainly due. In the La Plata Mountains the mass of intruded matter of this nature shown in the horizons exposed is comparable to the deformation which they have suffered over and above that affecting the lower formations, which are covered and therefore beyond observation; so that if the porphyry included in the hidden strata should bear the same proportion to the sedimentary rocks as in the observed section, the doming should be accounted for without additional uplift. *At Rico the structure and make-up of the dome* is much better exhibited, and though the theory that the observed structure might be due to a huge laccolith lying between the Algonkian and Paleozoic rocks was at one time entertained as a working hypothesis, it is now known that such a mass *of igneous rock does not exist, and that the amount* of deformation which the uppermost strata of the region underwent was several times in excess of the amount of igneous material which was intruded into the strata below them; that is, the formation of the Rico dome is mainly due to a central uplifting force, apart from any actual *intrusions of liquid rock material.* That such a force was also active in the La Plata uplift may well be believed, for there, as at Rico, the thickest laccoliths or sills occupy a zone, so far as the rocks now remaining are able to show, at a distance from the center of the dome, and it is on these peripheral intrusions that the estimate of the sufficiency of the porphyries to produce the observed structure was based.

THE RICO MOUNTAINS.

It has already been pointed out that there are *three natural topographical and geological divisions* of the Rico quadrangle, viz, the Rico Mountains, the Dolores Plateau, and the main Dolores Valley. The formations of the quadrangle and the general geologic structure determining their attitude and distribution having been discussed, it does not seem necessary to give further descriptive details concerning the plateau and valley areas, the geology of which is very simple. But the Rico Mountains are so complex in structure, igneous phenomena, and other respects that a résumé of their prominent features is desirable.

The Rico Mountains have been carved out of the domal uplift of several elements, already described. Naturally the peaks exhibit most clearly the formations taking part in the dome and their structure, while the deep dissection by the Dolores and its branches displays the features of the core of the uplift. The exhibition *of the latter geologic detail is, however, greatly* obscured by the superficial landslide materials, which assume a position of much local importance.

THE CIRCLE OF PEAKS.

The main summits of the Rico group arrange *themselves in harmony with the domal structure* in a circular zone. They are remarkably uniform in height, a dozen peaks exceeding 12,000 feet in elevation, while the highest, Blackhawk, is but 12,677 feet, or 4000 feet above the river at Rico. The Dolores River divides the group into two nearly *equal* crescents.

EASTERN SUMMITS.

Mountains south of Silver Creek.—While nearly all the peaks of the Rico group exhibit many characteristic features *of the local geology, these* lying to the south of Silver Creek are most note-slopes of Dolores Mountain seen in the central part of the view, and by many lines in the higher *summits, due to stratification or to intercalated* sheets of porphyry.

The higher portions of all these peaks consist of the red Cutler or Dolores strata with sharply contrasting grayish porphyries. Excellent sections of parts of the Cutler are to be found in several places, one on the slope of Whitecap Mountain being shown in the figure. The presence of a thin limestone conglomerate of the fossiliferous section of the Dolores very near the summit of Blackhawk Peak shows the projected horizon *of the La Plata sandstone to be but a few hun*dred feet above that mountain.

The influence of faulting is not self-evident in this illustration, yet the magnitude of the displacement on the Blackhawk fault is really shown, for the prominent limestone band of the Dolores *Mountain slope is dropped on that fault to a level* too low to permit its appearing within the field of this view on the farther side of Allyn Gulch.

The faults of this area are clearly shown in many places by their dislocation of porphyry sheets, but the grassy or timbered slopes seen in *fig. 1 often hinder a connected tracing out of* some of them. The splitting of the Blackhawk fault and the gradual decrease of dislocation are plainly visible on the slopes of Blackhawk Peak.

It may be seen from fig. 1 how well the occurrence of intrusive porphyry masses is exhibited on Whitecap Mountain and the narrow divide at the head of Deadwood Gulch. There are numerous other points at which these relations can be seen to advantage. One of these is on the high northern spur of Blackhawk Peak, where a large sheet makes cliffs several hundred feet high, shown in fig. 1. This mass extends *around the head of Silver Creek, covering a large* surface, as shown in part by the special map. The crosscutting relations of these porphyries, as they pass more or less obliquely from one horizon to another, are very plainly indicated.

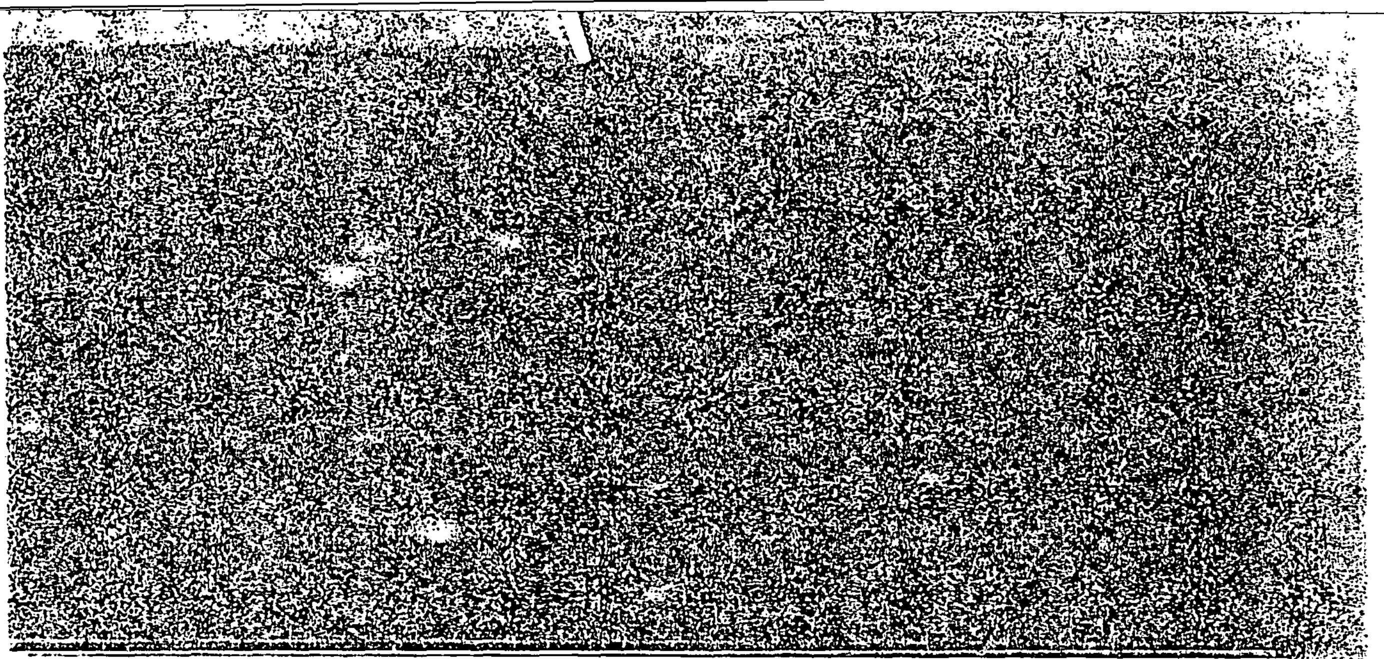
In the Rico report may be found several views *which will assist the reader in comprehending the* character of this portion of the mountains. One of these views presents the country lying east of Blackhawk Peak.

Telescope Mountain and vicinity.—The northeastern quadrant of the Rico Mountains is comparatively simple in its *geologic structure* and possesses but one mountain summit of prominence—Telescope Mountain. The Cutler red beds here assume almost exclusive surface importance, through their duplication by the Telescope Mountain fault. They are overlain by the Dolores formation at a short distance east of the area covered by the special map. The high divide running irregularly east from Telescope Mountain, which forms the watershed between the head of the Dolores River and Hermosa Creek, a branch of the Animas River, has many high points above timber line in which the several *formations may be studied.*

The Rico and upper Hermosa beds form a scarp facing the landslide area of C. H. C. Hill on the northwest ridge from Telescope Mountain as shown in fig. 5. The general structure of the mountain may also be seen in this view from exposures near the summit.

The minor faults of this region are conspicuous through dislocation of porphyry sheets, while the largest fault of the mountains is scarcely identifiable on the ground.

The porphyry intrusions of this section of the *Rico Mountains are less in number and magnitude* than in any other part, being limited to a few thin sheets and dikes in the upper half of the Dolores formation. It is worthy of note, however, that a large laccolith occurs just above the Dakota sandstone about one-half mile beyond the northeast corner of the area covered by the special map, on the



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the summit of Telescope Mountain. The entire area represented on the map as landslide territory exhibits the characteristic topographic detail. At the upper limit and on the southern border of the landslide tract seen in the view there is evidence of recent movement. In the Rico report may be found a picture of a tree split in two by movement now in progress, and even more convincing evidence is exhibited in the crushed or twisted timbers of mine workings throughout the tract.

Many small landslides have occurred on the northern slope of Telescope Mountain, but the blocks have broken up thoroughly in their fall and can scarcely be distinguished from ordinary avalanche débris.

WESTERN SUMMITS.

Mountains north of Horse Gulch.—The domal structure of the Rico Mountains, causing sedimentary beds to dip away from the center, is well shown in the high ridge leading from Sandstone Mountain through Elliott Mountain and northward across the quadrangle line. The general attitude of the strata on this line is represented in the view of Sandstone Mountain and the next higher point on this ridge, forming fig. 2 of the illustration sheet. The Jurassic and Dakota (Cretaceous) formations on the divides leading outward from Elliott, Sockrider, and Johnny Bull mountains exhibit the same structure.

Elliott Mountain is conspicuous in contrast to other peaks of the group by reason of the light-colored La Plata sandstone, which forms cliffs below the capping mass of porphyry.

The few faults of this area illustrate the lack of system in these fractures, and none of them produces results very marked in the present topography.

The porphyries of this district illustrate several intrusive relations of interest. The laccolithic form is fairly well shown in the mass of Elliott Mountain, the remnant of which is over 600 feet thick beneath the summit, while the porphyry is not present across the saddle north of the mountain. There are many sheets and small dikes and the forking or crosscutting of some of these bodies is clearly exhibited.

In one of the branches of Horse Gulch is very imperfectly exposed the rock of what may be one springs which give off strong odors of sulphureted hydrogen, near the head of Stoner Creek and on Johnny Bull Creek not far from Calico Peak.

The appearance of Calico Peak, with its talus heaps, less the vivid colors, is shown in Pl. VII of the Rico report.

Anchor and Expectation mountains.—Between the heads of Horse and Burnett gulches are two high peaks, Anchor and Expectation mountains, in which the crosscutting and branching of intrusive porphyry sheets is exemplified in many places. Indeed, so numerous are the visible forkings of the porphyry masses here that the conclusion seems by no means far fetched that all the more or less irregular masses shown by the map in the northwest-southeast zone from Johnny Bull Creek to beyond Landslip Mountain belong to one intrusion. The rocks are visibly different only in minor details of texture.

Peaks southwest of Burnett Gulch.—The southwestern summits of the Rico group exhibit the Cutler and Dolores red beds in their normal position dipping away from the center of the dome. On the ridge leading south from Storm Peak the La Plata and McElmo formations are seen in typical development. The porphyry bodies in the red beds have been referred to as probably connected with those of Anchor Mountain.

The most interesting local feature of this section is the landslide mass on the south slope of Landslip Mountain. This occurrence illustrates very well the various phases in the history of a landslide area, from the newly fallen blocks seen here adjacent to the summit of the mountain, through the older, partially disintegrated masses of the middle slopes, to the forest-covered débris near the stream below, where sinks and trenches still demonstrate the existence of slide masses.

Darling Ridge.—Between Horse and Sulphur gulches is a high tract cut almost in two by the head of Iron Draw. Here occurs the large stock of granular rock, quartz-monzonite, which appears to have been one of the later intrusions, if not the last, of the Rico center. The contacts of this stock are not well shown at any point, mainly on account of the shattered condition of the monzonite mass, which has resulted in talus or loose broken-rock piles, where larger landslides have not taken place. The metamorphosed condition of the sedimentary rocks on either side of the monzonite on Darling does not seem necessary to give further descriptive details concerning the plateau and valley areas, the geology of which is very simple. But the Rico Mountains are so complex in structure, igneous phenomena, and other respects that a résumé of their prominent features is desirable.

The Rico Mountains have been carved out of the domal uplift of several elements, already described. Naturally the peaks exhibit most clearly the formations taking part in the dome and their structure, while the deep dissection by the Dolores and its branches displays the features of the core of the uplift. The exhibition of the latter geologic detail is, however, greatly obscured by the superficial landslide materials, which assume a position of much local importance.

THE CIRCLE OF PEAKS.

The main summits of the Rico group arrange themselves in harmony with the domal structure in a circular zone. They are remarkably uniform in height, a dozen peaks exceeding 12,000 feet in elevation, while the highest, Blackhawk, is but 12,677 feet, or 4000 feet above the river at Rico. The Dolores River divides the group into two nearly equal crescents.

EASTERN SUMMITS.

Mountains south of Silver Creek.—While nearly all the peaks of the Rico group exhibit many characteristic features of the local geology, those lying to the south of Silver Creek are most noteworthy, because they show not only the domal structure, but the effects of faulting and igneous intrusion, and the sedimentary section is more completely displayed than elsewhere, on account of the comparatively insignificant development of landslide masses.

Fig. 1 illustrates many features of these peaks as seen from the west side of the Dolores, looking nearly due east. The prevalent dip to the southeast is particularly brought out by certain massive limestones of the upper Hermosa, which cross the paratively simple in its geologic structure and possesses but one mountain summit of prominence—Telescope Mountain. The Cutler red beds here assume almost exclusive surface importance, through their duplication by the Telescope Mountain fault. They are overlain by the Dolores formation at a short distance east of the area covered by the special map. The high divide running irregularly east from Telescope Mountain, which forms the watershed between the head of the Dolores River and Hermosa Creek, a branch of the Animas River, has many high points above timber line in which the several formations may be studied.

The Rico and upper Hermosa beds form a scarp facing the landslide area of C. H. C. Hill on the northwest ridge from Telescope Mountain as shown in fig. 5. The general structure of the mountain may also be seen in this view from exposures near the summit.

The minor faults of this region are conspicuous through dislocation of porphyry sheets, while the largest fault of the mountains is scarcely identifiable on the ground.

The porphyry intrusions of this section of the Rico Mountains are less in number and magnitude than in any other part, being limited to a few thin sheets and dikes in the upper half of the Dolores formation. It is worthy of note, however, that a large laccolith occurs just above the Dakota sandstone about one-half mile beyond the northeast corner of the area covered by the special map, on the farther side of Barlow Creek. This mass is the Flattop laccolith, a portion of which is situated in the Telluride quadrangle. It is not clear that this large intrusion has actual genetic connection with the Rico center, as will be explained in the discussion of the intrusions under "Geological history."

The landslide phenomena of Telescope Mountain proper are so clearly exhibited in fig. 5 as to require little further comment. The actual head of the slide area is on the ridge leading southwest to Nigger Baby Hill and less than 500 feet below of the principal centers of eruption. The porphyry is here seen to cut across the sediments, sending off numerous dikes and thin sheets. It is full of apparent inclusions and is penetrated by many angular arms of the wall rock. Unfortunately there has been great decomposition here and in addition the extremely complex relations are obscured to a large extent by soil, forest growth, and wash, so that the representation of the map is in some degree diagrammatic. In spite of these conditions, this locality is an excellent one in which to study complex intrusive relations.

Eagle Peak.—The westernmost of the Rico Mountains exceeding 12,000 feet in elevation is Eagle Peak. It lies beyond the line limiting the distribution of visible porphyry masses and therefore presents in least distorted form the simple structural relations of the sedimentary rocks taking part in the domal structure. Passing from the peak along the ridge to the west one has excellent opportunity to examine sections of the La Plata, McElmo, and Dakota formations and to observe the change from the domal structure to that of the Dolores Plateau.

Calico Peak.—The variegated coloring exhibited by the decomposed rock of this summit at the head of Horse Gulch has led to the current name Calico Peak. The original porphyry of this peak has been almost completely altered to a mass of alunite, kaolin, and quartz, impregnated with pyrite, the oxidation of which has produced the vivid red and yellow colors now so striking. Apparently the rock occurs as a small stock, although its contacts are concealed by talus or slide. It is supposed that the rock was similar to the porphyry of large orthoclase phenocrysts, of which a long dike crosses the slope of Johnny Bull Mountain, and which occurs only in this vicinity.

The formation of alunite is referable to sulphurous emanations, either directly by gases or indirectly through waters which have absorbed gases. That such activity has been specially marked in this vicinity is shown by existing Ridge is everywhere evidence of the proximity of the contact.

Although the monzonite body is large and such massive rocks usually cause rugged topography, such is not here the case. This fact is probably due to the thoroughly shattered condition of the stock, leading to rapid destruction of prominences by frost. The large number of small knobs and knolls, often with pinnacled spurs or summits, situated on the north side of Darling Ridge, are plainly separated by zones of fracture and brecciation and are themselves crumbling to pieces under frost action. The assignment of these knolls to the landslide area will be discussed in the next section of the text.

THE INNER SLOPES OF THE MOUNTAINS.

From the preceding description of the domal structure of the Rico Mountains and of the circle of prominent peaks it will be plain to the reader that the outer slopes of the mountain group exhibit simple structural relations of sedimentary formations and that igneous masses are few. It does not seem necessary, therefore, to give further descriptions of the peripheral portion of the Rico dome. In the heart of the mountains, where the structural complexities are great, where several formations not occurring elsewhere in the quadrangle have been revealed by the deep erosion of the Dolores and its tributaries, and where many intrusive bodies appear, the case is quite different. Here, however, the phenomena of local interest are so numerous that the reader must be referred to the Rico report for the greater part of the detail; the present descriptions will be confined to certain of the larger features of importance. In fact, it is not the fundamental relations of the formations, but rather the way in which these relations have been obscured, which will receive most attention.

LANDSLIDE AREAS OF HORSE GULCH.

The map and figs. 3, 5, and 6 of the illustration sheet show how completely the normal structure apparently splits into two or more small sheets before crossing the river, and many other irregularities may well be assumed to exist.

That this large porphyry body is in the main of laccolithic character is further indicated by the limited exposure of its base in the workings of the South Park mine in Silver Gulch. Several very small dikes or sheets of porphyry have been encountered in the mines of Newman Hill.

GEOLOGICAL HISTORY.

PRE-TERTIARY EVENTS.

Introductory.—The visible record of pre-Tertiary events in the geologic development of this area lies wholly in the sedimentary formations and their stratigraphic relations. From the discussion of the formations already given it appears that the section is nearly like that much better exposed, in its lower portions at least, in the Animas Valley. No marked local characteristic has been observed in the Rico formations of pre-Tertiary age, so that the course of events here can only be assumed to have been that of the surrounding province, an outline of which has been presented in the Telluride and Silverton folios. For the present folio it is considered sufficient to refer very briefly to the history preceding the continental uplift of the whole sedimentary section, in post-Laramie time.

Pre-Paleozoic era.—From the study of the Needle Mountains and the Animas Canyon sections it appears that the oldest rocks of this region are certain gneisses and schists, supposed to be of Archean age. The next younger series of rocks consists largely of igneous material, greatly metamorphosed and associated with some distinct sediments. Following the accumulation of this complex came a long period of sedimentation during which the Uncompahgre group of conglomerates, sandstones, and shales was deposited, in marked unconformity with the structures of older formations.

While the sequence of events is not wholly clear, it seems probable that great folding, faulting, and metamorphism of all the rocks as yet referred to was the next great step in the history of the region. The gneisses and schists are penetrated by a large number of granite masses, one known important body of gabbro, and many small dikes of diabasic rocks. Some of these rocks cut the Uncompahgre strata, and the comparatively unaltered textural condition of these intrusives appears to indicate that they are all later than the time of the above-mentioned folding to which the Algonkian sediments were subjected.

The presence of occasional fragments of granite or schist in the igneous intrusives of the Rico or La Plata mountains shows that these same old formations exist beneath later rocks in the country west of the Animas.

Paleozoic history.—Before the earliest Paleozoic sediments of the region were deposited there was a period of enormous erosion which appears to have affected the southern Rocky Mountain province and probably large areas of contiguous country. A peneplain of marked character was produced, which, on sinking beneath the later Cambrian sea, became the floor for the deposition of the Ignacio quartzite. If that formation is of Saratogan (Upper Cambrian) age, as now believed, it is reasonable to refer this great erosion to earlier Cambrian time.

As will be clear from the description of the Paleozoic formations, the epochs of sedimentation during the Ordovician, Silurian, and Devonian periods must have been almost insignificant compared with the intervals of nondeposition. The latter, however, were certainly not times of continental uplift to any great elevation above sea level, in this province, a land surface near sea level, because the erosion of the interval was nowhere sufficient to wholly remove the Ouray limestone at any point observed on the southern slopes of the San Juan region. As stated in a preceding section the absence of the Ouray limestone in the valley of Silver Creek, near Rico, is supposed to be due to erosion of this interval. That is, however, the only point adjacent to the San Juan Mountains as yet found where the Ouray is lacking at its appropriate place in the section. It may be that the area of greatest elevation and consequent erosion, of the time in question, was west of the San Juan area, in what is now the plateau district.

The Pennsylvanian sedimentation was of very different character from any that preceded it in the general area of southwestern Colorado. A long-continued oscillatory movement of the earth's crust caused frequent recurrence of conditions favorable to the deposition of limestones, shales, and sandstones, forming the complex called the Hermosa formation. Without visible break the Hermosa beds grade into those of the Rico (Permo-Pennsylvanian) and those into the overlying Cutler red beds, here assigned to the Permian.

The character of the Cutler formation is in general much like that of the lower portion of the "Red Beds" in many other places where no stratigraphic break separates them from strata containing a Pennsylvanian fauna. The fact that a break is now known to exist above the Cutler beds renders it impossible to assume that the Paleozoic section of the San Juan region is complete. There may have been deposited in this district a considerable thickness of Permian strata now entirely absent, owing to the pre-Dolores erosion.

Pre-Dolores uplift and erosion.—The angular unconformity at Ouray between the Dolores and older formations testifies to important uplift affecting the entire known Paleozoic section. The geographic extent of this uplift remains to be determined. The Cutler beds were sharply folded in the Ouray district, but apparently the region of maximum disturbance lay to the north and east of the San Juan, since on the south and west no relations of marked unconformity exist between the Dolores and Cutler formations.

The epoch of uplift and consequent erosion under discussion was followed by the deposition of the fossiliferous Dolores strata, but until the horizon within the Triassic system represented by those beds has been determined it is premature to assign the orogenic movement to late Paleozoic rather than to early Mesozoic time.

Mesozoic history.—Evidence that the Dolores formation is of Triassic age has been given. In the upper Dolores Valley, as in the San Miguel to the north and the Animas to the east, the Triassic strata are overlain with apparent conformity by the La Plata formation, yet on the northern side of the San Juan the La Plata transgresses the edges of older sediments and in places rests on the Archean, demonstrating that a period of continental uplift and great erosion intervened between the Dolores and La Plata epochs. Similar relations are known elsewhere in Colorado.

Whatever decision may ultimately be reached as to the relations of the Gunnison group as a whole, it is true that the upper of the assumed Jurassic formations, the McElmo, bears such strong lithologic resemblance, in some of its upper sandstone members, to the Dakota sandstone of the Cretaceous that it would be natural to assume that both formations belong to one epoch of sedimentation, rather than that there was a great stratigraphic break between them, involving the whole of Lower Cretaceous time.

The Upper Cretaceous section formerly present in the Rico region was doubtless like that which has been mentioned as present south of the La Plata Mountains. The alternation of shales and

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Through the San Juan uplift a large area was elevated far above sea level and has never again sunk below it. Erosion became active and degradation of the land area continued until it was reduced to a peneplain, possibly with a small mountainous island rising above it to which the Needle Mountains area belonged. The peneplain in question is that upon which the Telluride conglomerate (Eocene?) rests in the western San Juan and San Miguel mountains.

That this post-Laramie peneplain extended over the Rico quadrangle is evident. The nearest point at which it can now be seen is beneath the Telluride conglomerate in Mount Wilson, about 5 miles north of the northeast corner of the Rico quadrangle, at an elevation of 12,000 feet. In Sheep Mountain, 6½ miles to the northeast, the same horizon is shown. The general position of this plane in the Telluride quadrangle is represented and its significance is discussed in the Telluride folio.

TERTIARY PERIOD.

No surface rocks of the Tertiary period now exist in the Rico quadrangle, but it is necessary to refer to rocks of that age which formerly covered the area, in order to discuss intelligently the history of the Rico Mountains.

ACCUMULATION OF THE TELLURIDE CONGLOMERATE.

When the peneplain produced by erosion following the post-Laramie uplift had reached a certain stage of development the local conditions changed, so that a great amount of débris from the ensuing further erosion of the adjacent mountain masses was deposited upon it as a conglomerate. This formation, originally called the San Miguel conglomerate and afterwards renamed the Telluride, acquired a rapidly increasing thickness westward from its border in the Silverton quadrangle to the San Miguel Mountains. On its border it is 50 feet or less thick and is a coarse conglomerate. In Mount Wilson, a few miles north of Rico, it is about 1000 feet thick and consists of fine conglomerate, sandstone, or shale, the transition in texture and thickness being clearly exhibited in the intermediate area.

While much of the Telluride formation is well stratified and apparently of subaqueous origin, it seems possible that the whole may have been of fluviatile origin. In any case it is probable that the conglomerate was deposited over the Rico area with a texture and thickness corresponding to that [illegible] San Miguel Mountains.

ters in a general way with similar occurrences of the San Juan area. Porphyritic diorite, monzonite, or granite intrusions are known in the Telluride and Silverton quadrangles, and in some cases proof exists that they are later than some of the surface volcanics. The epoch of intrusion is, however, not at all clearly determinable with reference to the general time scale. The stock eruptions of the Telluride and Silverton areas are later than any known lavas of those districts, and as the Rico and La Plata stocks cut the laccolithic intrusions of similar magmas, it may well be that all eruptions of this type can be referred to the same epoch in the latter part of the Tertiary.

It has been pointed out that the Rico Mountains belong to the laccolithic group of the Henry Mountains type, in spite of local structural features not commonly supposed to exist in some of the similar centers of intrusion. These general considerations as to the time of the Rico intrusions have undoubtedly a bearing on the question as to the age of all the laccolithic groups of the plateau province. The conclusion reached here is in accord with that derived from the examination of the Elk Mountains, Colorado (see Anthracite-Crested Butte folio).

UPLIFT OF THE RICO DOME.

It was brought out in describing the structure of the Rico dome that three elements enter into its constitution, namely, domal uplift by folding, igneous intrusion, and faulting. Whether or not these are all resultant phases of the action of one great force is a question of far-reaching importance. The evidence to be found in the Rico Mountains is manifestly inadequate for the solution of this problem. It is clear, however, that the various manifestations of deep-seated forces at this point belong to different epochs and seem in some particulars independent of each other.

Quaquaversal folding.—It is believed that the quaquaversal folding which seems to have been the principal factor in the elevation of the Rico dome took place after the accumulation of a considerable thickness of volcanic rocks from San Juan eruptions—that is, in the Tertiary period and possibly in the Eocene epoch soon after the formation of the San Juan tuff. The erosion which produced the Telluride peneplain would surely have truncated the dome had this structure been of Mesozoic age. That plain is, however, nowhere seen in the Rico Mountains, although Blackhawk Peak still rises more than 600 feet above the level at which it [illegible] known important body of gabbro, and many small dikes of diabasic rocks. Some of these rocks cut the Uncompahgre strata, and the comparatively unaltered textural condition of these intrusives appears to indicate that they are all later than the time of the above-mentioned folding to which the Algonkian sediments were subjected.

The presence of occasional fragments of granite or schist in the igneous intrusives of the Rico or La Plata mountains shows that these same old formations exist beneath later rocks in the country west of the Animas.

Paleozoic history.—Before the earliest Paleozoic sediments of the region were deposited there was a period of enormous erosion which appears to have affected the southern Rocky Mountain province and probably large areas of contiguous country. A peneplain of marked character was produced, which, on sinking beneath the later Cambrian sea, became the floor for the deposition of the Ignacio quartzite. If that formation is of Saratogan (Upper Cambrian) age, as now believed, it is reasonable to refer this great erosion to earlier Cambrian time.

As will be clear from the description of the Paleozoic formations, the epochs of sedimentation during the Ordovician, Silurian, and Devonian periods must have been almost insignificant compared with the intervals of nondeposition. The latter, however, were certainly not times of continental uplift to any great elevation above sea level, in this province at least, since the thin formations of the Ignacio, Elbert, and Ouray epochs, though separated by intervals representing long periods of land conditions, are preserved in almost conformable relations in the Animas Valley, a few miles east of the Rico quadrangle. A fuller discussion of this feature of Paleozoic history is given in the Needle Mountains folio.

Apparently the deposition of the Ouray limestone was continuous from late Devonian into early Carboniferous (Mississippian) time, and the succeeding elevation must have produced, as did the earlier of the fossiliferous Dolores strata, but until the horizon within the Triassic system represented by those beds has been determined it is premature to assign the orogenic movement to late Paleozoic rather than to early Mesozoic time.

Mesozoic history.—Evidence that the Dolores formation is of Triassic age has been given. In the upper Dolores Valley, as in the San Miguel to the north and the Animas to the east, the Triassic strata are overlain with apparent conformity by the La Plata formation, yet on the northern side of the San Juan the La Plata transgresses the edges of older sediments and in places rests on the Archean, demonstrating that a period of continental uplift and great erosion intervened between the Dolores and La Plata epochs. Similar relations are known elsewhere in Colorado.

Whatever decision may ultimately be reached as to the relations of the Gunnison group as a whole, it is true that the upper of the assumed Jurassic formations, the McElmo, bears such strong lithologic resemblance, in some of its upper sandstone members, to the Dakota sandstone of the Cretaceous that it would be natural to assume that both formations belong to one epoch of sedimentation, rather than that there was a great stratigraphic break between them, involving the whole of Lower Cretaceous time.

The Upper Cretaceous section formerly present in the Rico region was doubtless like that which has been mentioned as present south of the La Plata Mountains. The alternation of shales and sandstones, with numerous coal beds, testifies to general conditions similar to those prevailing in the Rocky Mountain province, but differing somewhat in detail.

Post-Laramie uplift and erosion.—That the domal folding of the entire Paleozoic and Mesozoic section about the San Juan center occurred in the interval succeeding the Laramie epoch has been clearly established and is discussed at some length in the Telluride folio. The local uplifts of the Rico and La Plata mountains are imposed upon that older structure and to some extent obscure it. fluviatile origin. In any case it is probable that the conglomerate was deposited over the Rico area with a texture and thickness corresponding to that exhibited in the San Miguel Mountains.

No fossils have been found in the Telluride formation, hence its exact age is unknown. Its relation to the San Juan volcanic deposits shows it to have immediately preceded them and at present it is assumed to be of early Eocene age, although there are some reasons for thinking that the Telluride conglomerate may be correlated with the Arapahoe formation of the Denver region, assigned to the Post-Laramie part of the Cretaceous on paleontologic evidence. A full discussion of this question is given in the Telluride and Silverton folios.

SAN JUAN VOLCANIC ERUPTIONS.

The volcanic complex of the San Juan region is known to be the result of outbursts of various kinds and with various products, extending through Tertiary time. The earliest eruptions must have followed the deposition of the Tel ride conglomerate very closely, and it is probable, . m the considerable thickness of tuffs and lava . ws above that formation still remaining in the adj. nt San Miguel and San Juan mountains, that the 'ower volcanics extended over the Rico area, with a tuckness perhaps of several thousand feet. This question is particularly referred to in the Telluride folio, while the explanation of the absence of the volcanics in the Rico summits is presented below, in the discussion of the origin of the Rico domal uplift.

IGNEOUS INTRUSIONS OF THE RICO AND LA PLATA MOUNTAINS.

While no surface volcanics are now preserved in the Rico quadrangle, the numerous intrusive rocks which have been described belong undoubtedly to the Tertiary period. It is, indeed, possible that the monzonite or syenite stocks of the Rico and La Plata centers may represent channels through which extensive outpourings of lava took place. Be that as it may, there is every reason to correlate the igneous phenomena of these local centers [illegible] age. That plain is, however, nowhere seen in the Rico Mountains, although Blackhawk Peak still rises more than 600 feet above the level at which it appears in Mount Wilson, a few miles to the north.

The greater part of the uplift which has taken place has affected the whole Paleozoic section and the underlying Algonkian rocks and thus the small Rico dome comes to show close relationship with the much broader San Juan uplift. As has been stated already, the most prominent structure in the San Juan region is pre-Tertiary in origin, but there was also uplift in Tertiary time, and it is possible that the Rico dome is synchronous with the later elevation and a result of the same force. The same is true of the La Plata Mountains. But until the structural history of the San Juan region has been studied in much greater detail the relation between the local uplift of the Rico and La Plata mountains and the more nearly continental movements of the San Juan region can not be thoroughly discussed.

Age of the laccolithic intrusions.—The dikes, sheets, and small laccoliths of porphyry in the Rico Mountains belong to the group of diorite-, monzonite-, and granite-porphyries which are so widespread in the laccolithic mountain groups of the plateau country and also in the mountains of Colorado. That these rocks are in all these instances of approximately the same age is a natural conclusion in harmony with all known facts, although the definite evidence of Tertiary age is found in but few localities.

Evidence at Rico bearing on this question is limited to the general considerations above stated as to the age of the domal uplift. In the adjacent Telluride and Engineer Mountain quadrangles there are large laccolithic bodies of porphyries very similar to rocks of the Rico Mountains, and some of these are intruded into volcanic rocks, proving their Tertiary age. But no evidence has been found to indicate the particular epoch of this period in which the intrusions took place.

Stock eruptions and faulting.—In considering the nature of the forces which have produced the Rico uplift, it is apparent that there is a close analogy between the two phases of intrusive action and the two phases of structural uplift. The primary upward pressure at this center was one to which the whole section of Paleozoic and Mesozoic strata accommodated itself by folding, stretching, and no doubt by minor fissuring. It would appear to have been a gradually exerted pressure, of the kind assumed to have forced the magmas of laccoliths and analogous sheets between the strata of a sedimentary complex. Corresponding to this idea, it is found that the distinct porphyry sheets of the Rico Mountains are the earliest intrusions.

The fault blocks of the heart of the mountains, made up, at the exposures now seen, of Algonkian schists and quartzites, have been thrust up through the folded strata with little or no evidence of contemporaneous folding of the adjoining beds. This is also the relation of the Darling Ridge monzonite stock, as far as can be seen, and also of the similar stocks of the La Plata, Telluride, and other neighboring quadrangles. Such fault blocks and such masses of igneous rocks seem alike due to forces suddenly exerted, producing vertical fracture instead of doming. With such an analogy in mind, the suggestion naturally arises that a mass of magma, forming a stock in greater depth, may have followed the upthrust blocks now revealed. Such a hypothesis requires the assumption of very direct connection between the propelling forces of magmas and those of structural uplift.

Connection between folding and intrusion.—If folding and intrusion at the Rico center be referred to the action of the same great force, it is difficult to explain why larger amounts of magma were not intruded into the strata of the Rico dome, in view of the large porphyry masses of probably contemporaneous origin occurring near at hand in comparatively undisturbed beds. The Flattop mass of porphyry, exceeding in bulk all the sheets of the Rico Mountains put together, occurs just at the northeast base of the dome, but similar large bodies occur on the San Miguel River in the Telluride quadrangle, 20 miles from the Rico uplift, and another occurs in Hermosa Peak, a few miles to the east. The stocks of the Telluride quadrangle appear likewise to be distributed without visible relation to any structure of the sedimentary formations. In other words, it appears to be the case that, while laccolithic intrusions and stock eruptions have occurred at the Rico and La Plata centers, both forms of intrusion have also taken place not far away in much greater volume, at points seemingly independent of such centers. It is to be hoped that more extended studies of the San Juan and adjacent regions may throw light on the relations of these various phases of intrusion of magmas to structural movements of the earth.

PHENOMENA CONNECTED WITH IGNEOUS INTRUSION.

Aside from the mechanical features of intrusion, which have been referred to, the principal phenomena connected with the igneous intrusions of the Rico Mountains are those of contemporaneous metamorphism and of solfataric exhalation which appears to have continued down to the present time.

Contact metamorphism.—Contact metamorphism of the calcareous strata adjacent to the monzonite stock is very pronounced at nearly all places where these rocks are exposed in the vicinity of the intrusive. The character of the alteration is such as might be expected from the action of mineralizing agents, as chlorine, fluorine, and heated water carrying those gases and perhaps others in solution. The metamorphism referred to consists in the formation of garnet, pyroxene, vesuvianite (?), and possibly other silicates of alumina, with magnesia, iron, and lime, and in the deposition of specular iron in scales, either impregnating the rocks or ... in this ... sion. The eastern end of the monzonite is just above the street in Piedmont, and there must have been fissures traversing the strata in the prolongation of the principal axis of the stock. These may have given heated solutions the necessary access to the limestone at the places now seen. So far as observed, such contact metamorphism is confined to the zone about the stock, with the exception of one place in the shattered zone, between the forks of the Blackhawk fault, where garnet masses and specular iron occur near a small porphyry dike.

Solfataric action.—While no evidence can ever be discovered proving that the surface phenomena ordinarily known as volcanic attended the deep-seated intrusions in the Rico dome, certain processes which are generally supposed to characterize zones near the surface have been active in the horizons now revealed by erosion. One of these processes is the decomposition of rocks by sulphurous vapors or by solutions that have absorbed those vapors, and the production of alunite. This substance is formed at the surface in the crater of Solfatara, near Naples, and is a common product of the sulphurous emanations of volcanoes known from this locality as solfataric exhalations. But the process is not necessarily connected with solfataras of typical volcanoes, and the term has been gradually extended to cover the metamorphosing action often consequent on eruptions which have been accompanied by mineralizing agents of sulphurous character, even when taking place in depth.

The orthoclase-bearing porphyry mass of Calico Peak has been almost wholly decomposed by such agents, alunite and kaolin being the principal products.

Existing sulphur springs.—It is especially noteworthy, in connection with the evidence above given of former intense solfataric action, that there are numerous springs of water heavily charged with sulphureted hydrogen issuing to-day from the slopes of Stoner and Johnny Bull creeks and of other tributaries of the West Dolores north of Johnny Bull Creek. The waters of these springs are surface waters, as they are influenced directly by the rainfall of the season and dry up at times, but the sulphurous gases escape continuously. The exclusive presence of these springs on the west side of the dome, extending from the immediate vicinity of the solfataric center at Calico Peak toward the West Dolores, suggests that these exhalations really belong to a later solfataric period of this eruptive center.

ORE DEPOSITION.

After the uplift of the Rico dome, the intrusion of the igneous rocks, and at least a portion of the fault fissuring there was a period of extensive ore deposition in the rocks now forming the Rico Mountains. While the age of the ore deposits can not be closely determined, it is in every way probable that they correspond in time to the deposits of the La Plata Mountains and that they belong to the great epoch of ore deposition which succeeded the early Tertiary igneous intrusions or more typical volcanic eruptions in many parts of the Rocky Mountains. Apparently the more typical laccolithic mountain groups of the plateau country to the west do not contain ore deposits in an abundance at all corresponding to their development in the La Plata and Rico mountains, but whether that fact is connected with their situation remote from the great centers of eruptive activity or with local causes can not now be determined. It would, however, appear natural that more extensive deposition of ore minerals should occur in a center like the Rico Mountains, where there has been so unusual an amount of fissuring, affording channels for the circulation of metal-bearing solutions.

EROSION OF THE RICO DOME.

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-tion.—While no evidence can ever -roving that the surface phenomena -wn as volcanic attended the deep- -s in the Rico dome, certain proc- generally supposed to characterize surface have been active in the -evealed by erosion. One of these - decomposition of rocks by sul- -or by solutions that have absorbed -d the production of alunite. This -med at the surface in the crater of Naples, and is a common product -us emanations of volcanoes known -ity as solfataric exhalations. But -t necessarily connected with solfa- volcanoes, and the term has been -ded to cover the metamorphosing -sequent on eruptions which have -d by mineralizing agents of sul- -ter, even when taking place in

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question. Naturally the work of distinct epochs of Tertiary erosion can not be recognized in the Rico district, and the present discussion is, therefore, directed to the local problem as to the sculpturing of the Rico dome. This erosion began with the rise of the dome, at some unknown time in the Tertiary period, and has continued to the present day, although discussion is here confined to pre-Glacial erosion. The glaciation here referred to is that of which evidence is observable, and is not necessarily the earliest of the region, as will be explained in a later paragraph.

Sculpturing of the dome.—At the inception of the Rico dome the volcanic rocks which covered the San Juan country were being attacked on all sides by streams whose positions were probably determined by the distribution of the volcanic materials. So long as eruption continued the stream courses were constantly liable to alteration by lava flows, but with the temporary cessation of volcanic activity each stream would maintain the course it then held, deepening its channel and sapping at its head to extend its canyon into the central mountainous region. It seems probable that the Dolores River had assumed its present course previous to the formation of the Rico dome, since, supposing that the surface at the time the dome was formed was sufficiently smooth for the development of consequent drainage on its slopes, it is difficult to understand how one of the radial streams thus resulting could have gained so distinct an advantage over the others that it would finally cause their complete diversion. The relations of hard and soft rocks in the region to the north of the dome are such that it seems as if diversion of the radial streams on the northern slope must have been accomplished by the western branch of the Dolores River long before any stream originating on the southern slope of the Rico dome could have cut its valley backward through the hard core of the group to the north side of the dome structure.

The actual amount of erosion since the Rico uplift can not be estimated, since its effects are not separable from those of the epoch preceding. It is believed, however, that the volcanic rocks had not been removed entirely and that, as in Mount Wilson, to the north, sediments above those now exposed were present, up into the Mancos shale, at the time of uplift.

Whether the Dolores was flowing in a ...

The monzonite stock on the west side of river has been sufficiently resistant to form a both south of Aztec Gulch and in the main di- south of Horse Gulch, though in neither place it reach to as high an elevation as the porph- of the adjacent peaks.

The distribution of the laccolithic porph- masses in the upper part of the Dolores form- has determined the zonal grouping of the pri- mountain peaks about the center of the dome s- ture. In fact, it is to these porphyries th- Rico Mountains owe their existence. Had t- not been encountered by the streams, the l- in dissecting would have given to the dom- molding scarcely different from that which - have impressed upon the adjacent areas of - mentary rocks; the concentric outcrops of harder beds would be expressed in knolls curving ridges, but the general elevation wo- have been much less than at present.

GLACIATION OF THE RICO MOUNTAINS.

It is known that the higher portions of the Juan region were practically covered by an sheet during a late stage of the Glacial ep- It is, therefore, not strange to find evide- of recent local glaciers in the Rico Mounta- Reasons exist for believing that the San Ju- Mountains were also glaciated in an earlier p- tion of the Glacial epoch, but evidence bear- on this question is found in the Rico dis- only in certain high-level gravels of the Dolo- Valley.

Evidence of recent glaciation.—The record of glaciers in the Rico Mountains is seen in cer- topographic forms, in rock scoring, and in ac- mulations of débris, but none of these is strikingl- prominent or characteristic, from which it appe- that because of their somewhat lower altitude an- their isolation the Rico Mountains were not completely dominated by the ice as were t- higher mountains adjacent. They formed a lo- center of accumulation, and though the basins - Rico were probably deeply buried in snow the- were but few places in which the accumulati- became sufficiently deep for the consolidati- the snow into true glacial ice.

That glaciers were not prominent for any gr- length of time seems clear from the absence of marked glacial cirques or amphitheaters in th-angle appear likewise to be distributed without visible relation to any structure of the sedimentary formations. In other words, it appears to be the case that, while laccolithic intrusions and stock eruptions have occurred at the Rico and La Plata centers, both forms of intrusion have also taken place not far away in much greater volume, at points seemingly independent of such centers. It is to be hoped that more extended studies of the San Juan and adjacent regions may throw light on the relations of these various phases of intrusion of magmas to structural movements of the earth.

PHENOMENA CONNECTED WITH IGNEOUS INTRUSION.

Aside from the mechanical features of intrusion, which have been referred to, the principal phenomena connected with the igneous intrusions of the Rico Mountains are those of contemporaneous metamorphism and of solfataric exhalation which appears to have continued down to the present time.

Contact metamorphism.—Contact metamorphism of the calcareous strata adjacent to the monzonite stock is very pronounced at nearly all places where these rocks are exposed in the vicinity of the intrusive. The character of the alteration is such as might be expected from the action of mineralizing agents, as chlorine, fluorine, and heated water carrying those gases and perhaps others in solution. The metamorphism referred to consists in the formation of garnet, pyroxene, vesuvianite (?), and possibly other silicates of alumina, with magnesia, iron, and lime, and in the deposition of specular iron in scales, either impregnating the rocks or, more commonly, in thin crusts in fissures. Such alteration of the calcareous strata may be seen on the north side of Darling Ridge, near the blowout in Horse Gulch, and down near Piedmont. If the metamorphosed stratum is a limestone the matrix for the silicates named is usually white crystalline marble.

The great metamorphism of the Devonian limestone in the Dolores Valley at Rico is so clearly of the kind described that it is considered probable that this change is also due to the monzonite intru-

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EROSION OF THE RICO DOME.

General statement.—The San Juan and adjacent country appears to have been a continental tract during the whole of Tertiary time. Erosion must, therefore, have been continually in progress during that period. The work of degradation was repeatedly interrupted and in great measure undone by vast volcanic accumulations in several different epochs. Further, the erosive power of streams varied greatly, according to the alternating elevation or subsidence of the region, which probably continued during the period in

exposed were present, up into the Mancos shale, at the time of uplift.

Whether the Dolores was flowing in a shallow valley or deep canyon previous to the domal uplift at Rico can not be surmised, but before the completion of the structure the stream had doubtless cut a deep trench well down toward the base of the volcanic rocks which are supposed to have covered the region, and possibly into the Mesozoic sedimentary rocks, upon which they probably rested. This erosion belonged to the epoch of deformation. It was succeeded by continued erosion of the present epoch as arbitrarily limited by the completion of the distinct uplift.

With the downward cutting there has doubtless been concomitant elevation, but of this there is no evidence in the immediate vicinity of Rico, though some 16 miles or so to the south there are gravel beds about 400 feet above the present valley floor, showing the former position of the stream bed and indicating an uplift since their deposition. The effect of erosion within the mountains has been as if the river had cut its way at once to the present position and then side streams and gullies had completed the grading of the slopes. It is believed, however, that several distinct uplifts have occurred, but the pauses between them left no records because of the fact that the river was cutting its channel and not at any time widening its valley, so that the valley was successively deepened, and under conditions of heavy precipitation the slopes of the valley walls were gradually reduced without the production of terraces.

The softer rocks have been carved away, leaving the more indurate as cliffs or steep slopes between more gentle acclivities and determining the positions of the main mountain masses. The rocks which have been sufficiently massive to form mountain caps are mostly intruded porphyries, though the La Plata sandstone always rises as a knob above the general level of the adjacent ridges. Of the few high peaks capped by other sediments than La Plata, Telescope Mountain is the only one not protected by a very massive sheet of porphyry lying within 100 to 200 feet of the top.

length of time seems clear from the absence of marked glacial cirques or amphitheaters in the higher mountains. The basin at the head of the small gulch next east of Allyn Gulch, in the eastern part of the group, is the only one of the region which strongly resembles a typical cirque. It is also noteworthy that the side gulches of the mountains seldom possess the profile outline characteristic of valleys filled by glaciers, the only two exhibiting the U-shaped form being Silver and Horse gulches, the largest and deepest of the group.

Striated or grooved rock faces have been noted in several places, notably in Deadwood and Silver gulches and near the head of Johnny Bull Creek, west of Calico Peak.

Glacial débris retains distinct morainal form only on the southeastern slopes of the mountains, at the head of two branches of Scotch Creek, in the Engineer Mountain quadrangle. These were deposited by short glaciers of small dimensions. In other places the gravels supposed to be of glacial origin are mingled with avalanche, landslide, or wash débris, and could not be shown on the map. They occur on various ridges or mountain slopes and in certain gulches, and details of their observed distribution were given in the Rico report.

The rounded ridge at the entrance to the valley of Silver Creek has an external appearance similar to that of kames or eskers, but it is really composed of sedimentary rocks and intrusive porphyry and is merely capped by gravels. It is consequently a form of erosion rather than of construction.

Collectively the phenomena observed are believed to warrant the conclusion that true glacial streams at one time existed on the southeastern slopes of the mountains, in the valley of Silver Creek and its tributaries, and in Deadwood Gulch, and that in the upper part of Horse Gulch there were important accumulations of ice which may or may not have reached into the lower part of the valley. If others existed, their marks have been obscured by surface materials of another origin or by recent erosion.

Valley gravels related to glacial deposits.—A group of gravel deposits which may be tentatively referred to the close of the recent (Wisconsin) stage of glaciation occurs in the Dolores Valley at many points from the Rico Mountains downward. These gravels are seen in the terrace upon which the town of Rico is partly built, and on the similar and probably corresponding bench which occurs about 40 or 50 feet above the river bed north of the mouth of Sulphur Creek. The gravels are best exposed in the cutting for the roadway to the railroad station at Rico, but are known to form the edge of the terrace for nearly half a mile to the south. Occasional remnants of corresponding gravel benches occur down the Dolores River as far as the mouth of Bear Creek. South from Montelores the bench is from 10 to 30 feet above the present stream, and it seems to slope down the valley at a slightly greater grade than that of the Dolores River. This bench is not entirely depositional, since occasional exposures show rock in place. Just north of the mouth of Ryman Creek the inclined and truncated edges of the Cutler beds are shown to be covered by a thin capping of gravel, and east of Montelores the eroded surface of the porphyry is but partially concealed.

Less conspicuous remnants of a gravel terrace occur along the Bear Creek flat. This terrace is at about the same elevation above the present stream as the Dolores terrace and seems to be closely related to it genetically. At the angle of the union of the streams a terrace remnant appears to be common to both. The terrace gravels of Bear Creek came, of course, from the La Plata Mountains. West of the mouth of Bear Creek this bench is inconspicuous or wanting. It seems probable that these Dolores Valley gravels represent the scanty morainal materials of the Rico glaciers transported and deposited. The amount of stream cutting below the gravel-covered terraces is consistent with this idea.

Ancient glacial (?) gravels.—Coarse gravel or bowlder beds, which from their position suggest a considerable former extent of such materials, occur at numerous points in the Dolores Valley at several hundred feet above the present stream. The most northerly of these observed occurrences is on the ridge south of Aztec Gulch, near Rico, where, at an elevation of 9500 feet, or about 700 feet above the river, an excavation in the wooded surface reveals a mass of very round bowlders lying in fine gravel. Among the rocks represented are blue limestone, greenish sandstone, and vein quartz. The bowlders are very unlike the angular fragments which are sparingly scattered about the surface. These angular blocks, often 3 feet or more in diameter, seem to have come from up the river, for red Dolores sandstone is common among them. Bowlder gravels have also been exposed at a lower level on this same ridge in prospects near the line of the Calumet vein, about 300 feet above the river.

On the slope below the tufa bench south of Sulphur Creek, southwest of Rico, at about 300 feet above the river, there are several patches of coarse gravel beds. Among the fragments noticed here was one block, nearly 3 feet in diameter, of the peculiar hornblendic porphyry known only in dikes in the Algonkian schists above Rico.

Further down the Dolores Valley other similar gravel patches occur at this general level of 300 feet above the river. They are especially well shown on the west side of the river between Snyder's ranch and Rio Lado and have been noted also near the mouth of Bear Creek. Possibly they occur in small remnants much farther down the river. A specially good exposure was noted near the mouth of Tenderfoot Creek, where the pebbles average about 4 or 5 inches in diameter, character of the bowlders and the meager evidence concerning their origin scarcely warrants the assumption of any particular relation to more ancient glaciation. Gravels of high level are abundant on all sides of the San Juan, and in the forthcoming Ouray folio strong evidence indicating a pre-Wisconsin glaciation will be given.

LANDSLIDES.

The landslide areas of the Rico Mountains, which assume unusual importance, have been described as to their character and local distribution, and it remains to refer briefly to their age and the evidence of their origin. A much fuller treatment of the subject is given in the Rico report.

Age of the landslides.—The epoch of the Rico landslides may be said to extend backward from the present day to their beginning, at a remote period not accurately determinable. From the great number of the slides in this limited region and the conditions of their distribution it must be assumed that they are primarily due to some very unusual force, shattering the rocks to a remarkable degree and principally exerted at the beginning of the landslide epoch. It is therefore of prime interest to ascertain when these slides began.

Of all the phenomena of Quaternary age in this region there is none affording definite proof as to the remoteness of the time at which the fracturing of the formations took place. The principal changes in the topography since the landslides began have been caused by the slides themselves. There has been practically no erosion in the Dolores Valley or in the more evenly graded reaches of its local tributaries in the landslide epoch. All the distinct alluvial formations, as flood plains and the fans or aprons at the mouths of streams tributary to the Dolores, are referable to activities during the landslide epoch. Even the glacial deposits seem to afford little evidence as to the age of the first landslides. The main traces of glacial deposits are in the eastern portion of the Rico Mountains, where landslides have not occurred; and the gravel deposits, which seem to be of glacial origin, have in most cases been more or less rearranged, so that little weight can be placed on conclusions drawn from their present position. The landslide period was apparently contemporaneous with the glaciation, or nearly so.

Relations to topography.—From the details regarding the various slide areas which have already been given and from the illustrations, it is evident that the topography of the Rico Mountains had acquired almost the detail it now exhibits when the landslides began. The only considerable modification of that topography in the intervening time to the present has come directly from the landslides or indirectly through the rapid breaking down of the principal slide areas. The valley of the Dolores, at the foot of C. H. C. Hill, must have been of the exact type now seen above Marguerite Draw. The stream bed of Horse Creek has plainly been interrupted by the Puzzle slide.

The primary conditions for a landslide may be generally stated as a thoroughly fractural state of the rocks on steep slopes, permitting the force of gravity to cause the fall; and were all the rocks of a mountain district to be uniformly shattered the mountains of most precipitous and irregular form would naturally experience the most extensive landslide action. But in the Rico district some of the most rugged mountains have undergone no visible degradation by landslips, even in the heart of the area most affected. Sandstone Mountain is the most striking instance of this immunity.

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One effect of this saturation by circulating waters has been to keep the fracture lines of attrition matter and many layers of crushed sandy shale in a soft condition, favorable to the slipping of more or less extensive masses whenever the support weakened sufficiently. Secondary slides of this sort must have been frequent ever since the original shattering of the formations, and they are still taking place.

The more exposed and isolated landslide blocks, if prevented from further slipping en masse, break up gradually, while a talus slope or an avalanche track often denotes the course of the more rapid disintegration.

Origin of the landslides.—The immediate cause of the Rico landslides is manifestly the very unusually shattered condition of the rock formations on steep slopes, and the discussion of origin must be directed to the seat and nature of the force to which the intense shattering is due. The evidence concerning this force contained in the observations which have been recorded may be summarized as follows:

1. The principal landslides are confined to a small circular area in the heart of the Rico uplift, but do not cover all of that area.

2. The slides are more recent than the topographic details of the mountains and valleys, except only some recent and minor features.

3. The shattering of the rock varies locally in degree.

4. The shattering is independent of lithologic character and structural attitude of the formation, and there is nothing in either of these conditions especially favorable to landslides.

5. The principal landslide slopes are in the courses of many known faults, but several intensely faulted areas of rugged topography do not exhibit landslides.

6. Many fault veins seem to have been opened again by the shock producing the shattering of the formations.

7. The shattering extends below the surface zone of actual sliding and to unknown depths.

The consideration of all observed facts leads to the comprehensive statement that in geologically very recent time a part of the central portion of the Rico Mountains suffered a severe shock, shattering the rocks at the surface and to unknown depths. As a result of this shattering many landslides have occurred where other conditions were favorable. This shock must have had its source

at an elevation of 700 feet above the Dolores River on the northern edge of the monzonite arm from Darling Ridge are of Glacial origin, they indicate a much greater accumulation of such débris in the valley than would be suggested by any other occurrences. But even if they are Glacial, the recent work of the river seems to have been largely the removal of the gravels, with little cutting into the underlying rock. In Deadwood and Allyn gulches the streams have cut down through the unconsolidated gravels of Glacial origin, but this is a task which they could have easily accomplished in a short time. Similar indications of the small effect of post-Glacial bed-rock erosion are seen in Silver Creek, where the stream has locally excavated narrow canyons in the wider valley of Glacial origin, but these canyons have in no instance exposed the bed rock to a depth of more than possibly 20 feet, and in many places the stream is working on débris of very recent origin, which has been thrown into its channel from the side gulches and ravines. All the evidence serves to point to the recency of the Glacial occupation and to the small amount of erosion which has since ensued. The present topography is in no essential feature different from what it was previous to the accumulation of the ice. Before that the streams had found their present courses and had practically assumed their present grades.

In the higher parts of the mountains, however, the ordinary atmospheric agencies have been active and large amounts of talus and slide rock are seen on many of the steeper slopes.

Modification of topography by deposition.—The greatest change in the topography of the region since the great erosion has been effected through the agency of landslides. Throughout the larger tracts which are shown on the map the landslides have modified the form of the ridges and mountain slopes and have to some degree filled up the valley bottoms, especially of the Dolores opposite C. H. C. Hill and of Horse Creek. Apparently the streams in their lower courses have not as yet been able entirely to remove this landslide débris.

In the valley of the Dolores there are various deposits of stream gravels, and the map shows the distribution of the more recent deposits. Remnants of terraces in several places indicate former deposits, but these are not always clearly distinguishable from débris of other origin.

While the lateral tributaries of the Dolores have no bottom deposits of importance, several of them have built up very decided alluvial cones at their where, at an elevation of 9500 feet, or about 700 feet above the river, an excavation in the wooded surface reveals a mass of very round bowlders lying in fine gravel. Among the rocks represented are blue limestone, greenish sandstone, and vein quartz. The bowlders are very unlike the angular fragments which are sparingly scattered about the surface. These angular blocks, often 3 feet or more in diameter, seem to have come from up the river, for red Dolores sandstone is common among them. Bowlder gravels have also been exposed at a lower level on this same ridge in prospects near the line of the Calumet vein, about 300 feet above the river.

On the slope below the tufa bench south of Sulphur Creek, southwest of Rico, at about 300 feet above the river, there are several patches of coarse gravel beds. Among the fragments noticed here was one block, nearly 3 feet in diameter, of the peculiar hornblendic porphyry known only in dikes in the Algonkian schists above Rico.

Farther down the Dolores Valley other similar gravel patches occur at this general level of 300 feet above the river. They are especially well shown on the west side of the river between Snyder's ranch and Rio Lado and have been noted also near the mouth of Bear Creek. Possibly they occur in small remnants much farther down the river. A specially good exposure was noted near the mouth of Tenderfoot Creek, where the pebbles average about 4 or 5 inches in diameter, though some reach 8 or 9 inches. Among the rocks represented here are porphyries, sandstone, limestone, quartzite, vein quartz, and shale.

These high-level bowlder beds are considered as mere remnants of important deposits belonging to the epoch when the floor of the valley was 300 feet or more above its present stream bed. From the evidence, common in southwestern Colorado, of slight stream erosion since the last Glacial epoch, it would seem necessary to conclude that the gravels under discussion are older than the recent (Wisconsin) stage of glaciation. But the waterworn position. The landslide period was apparently contemporaneous with the glaciation, or nearly so.

Relations to topography.—From the details regarding the various slide areas which have already been given and from the illustrations, it is evident that the topography of the Rico Mountains had acquired almost the detail it now exhibits when the landslides began. The only considerable modification of that topography in the intervening time to the present has come directly from the landslides or indirectly through the rapid breaking down of the principal slide areas. The valley of the Dolores, at the foot of C. H. C. Hill, must have been of the exact type now seen above Marguerite Draw. The stream bed of Horse Creek has plainly been interrupted by the Puzzle slide.

The primary conditions for a landslide may be generally stated as a thoroughly fractured state of the rocks on steep slopes, permitting the force of gravity to cause the fall; and were all the rocks of a mountain district to be uniformly shattered the mountains of most precipitous and irregular form would naturally experience the most extensive landslide action. But in the Rico district some of the most rugged mountains have undergone no visible degradation by landslips, even in the heart of the area most affected. Sandstone Mountain is the most striking instance of this immunity.

Relations to other Quaternary phenomena.—The ordinary processes of degradation operative in the high mountain regions of Colorado have of course been active in the Rico Mountains during the long epoch of landslide action, and it scarcely need be pointed out that all the destructive agencies must have been especially effective within the landslide areas. The shattered landslip blocks themselves have been in high degree vulnerable to the attacks of solvent waters, frost, etc., and have in many cases rapidly disintegrated. The whole slope of Darling Ridge, as of other landslide areas, is practically without surface drainage channels, so the Rico Mountains suffered a severe shock, shattering the rocks at the surface and to unknown depths. As a result of this shattering many landslides have occurred where other conditions were favorable. This shock must have had its source in greater or less depth, and may be referred to as earthquake shock.

Two important sources of earthquake shock are specially recognized, viz, that originating in the relief of tension arising from structural movements of the earth's crust, and that connected with volcanic phenomena. The Rico Mountains represent a center of upheaval and intense faulting, and of igneous intrusions of a nature not strictly volcanic. It seems natural to suppose that seismic disturbances must have taken place at the surface of the Rico dome during the periods of faulting and during the intrusion of at least the monzonite magma in the channels represented by the stocks of to-day. But those disturbances took place at so distant an epoch that the connection of the shocks now under discussion with either of them is not plausible.

RECENT GEOLOGICAL HISTORY.

Many of the features of post-Glacial geology at Rico are inseparable in origin from similar features of Glacial and earlier time, since in those parts of the area that were not covered by ice similar processes of general erosion and of local deposition were active throughout the Glacial stage. For this reason, in referring to certain phenomena as Recent, there is no intention of limiting their age to the post-Glacial, but rather to indicate that certain conditions have continued down to the present time. The Recent phenomena of the Rico region are mainly erosion and deposition. The latter includes landslides, talus, and avalanche materials, river gravels, and spring deposits, which have been described as formations. The processes of their formation are so commonly known that but little further reference to them seems necessary.

Post-Glacial erosion.—If the gravels occurring deposits, but these are not always clearly distinguishable from débris of other origin.

While the lateral tributaries of the Dolores have no bottom deposits of importance, several of them have built up very decided alluvial cones at their mouths. The more important of these are represented on the map.

Small deposits of calcareous sinter or tufa have been noted at various points on the banks of the Dolores, and several of them are shown on the map. At a number of these points the spring waters are still highly charged with carbonate of lime and deposition is still going on.

It will be noted that the effect of nearly all of these recent agencies is to modify the form of the mountains existing before the Glacial epoch and the beginning of the landslides, by producing gentler forms of the ridges and by filling up in some degree the various valleys.

Gas springs.—Emanations of carbonic acid gas and of sulphureted hydrogen accompany many springs of water in the Rico region. The former is continually escaping in large quantities in the central part of the area, while the latter is noted in many places on the west side of the mountain group in the drainage of Stoner and Johnny Bull creeks. Both gases doubtless have their origin in chemical changes which are going on at a greater or less depth beneath the surface, and the waters with which they are associated may or may not be of deep-seated origin. In some cases they certainly are not, for at the sulphur springs the water increases and diminishes with the humidity or dryness of the season, and at certain times the flow of water ceases entirely, while the gas continues to escape. It appears that in such instances the gases have found the same channels along which the waters are circulating and that the two mix and escape together. In the section on "Economic geology" Mr. Ransome tells of the frequent appearance of carbonic acid gas in mine workings.

June, 1904.

ECONOMIC GEOLOGY OF THE QU

By F. L. Ransome.

INTRODUCTION.

The principal ore deposits of the Rico quadrangle are confined to its northeast corner, and are included within the area of about 35 square miles covered by the Rico special map. The mining district is nearly coextensive with the isolated group of peaks which have been described in the foregoing pages as the Rico Mountains. Rico, a town of a few hundred inhabitants and the seat of Dolores County, lies nearly in the center of the district, on the Dolores River, which traverses the area from north to south. The Rio Grande Southern Railway connects the town with the Denver and Rio Grande system at Durango on the south and at Ridgeway on the north.

The following general account of the ore deposits is for the most part condensed from a report entitled "The Ore Deposits of the Rico Mountains, Colorado," published in the Twenty-second Annual Report of this Survey in 1902. To that report the reader is referred for detailed descriptions of individual mines.

HISTORY OF MINING DEVELOPMENT.

Records of the discovery and early development of the Rico ore deposits are fragmentary and often conflicting. The first recorded attempt to prospect the region was in 1861, when Lieutenant Howard and other members of John Baker's expedition into the San Juan region made their way over the mountains from the east. Eight years later Shafer and Fearheiler built a cabin on Silver Creek, near its junction with the Dolores River, and located several claims. One of these, the Pioneer, subsequently gave its name to the mining district.

In 1872 R. C. Darling and others erected an adobe furnace and attempted to smelt ores from what are now known as the Atlantic Cable, Aztec, Phoenix, and Yellow Jacket claims. They were unsuccessful, and it was not until 1877 that active prospecting was resumed in the Pioneer district.

In 1879 rich oxidized silver ore was discovered on Nigger Baby Hill, and the future productivity of Newman Hill was foreshadowed by the shipment to Swansea of some ore from the Chestnut vein. The town of Rico at once sprung into existence.

In October, 1887, the largest and richest of the blanket deposits on Newman Hill was discovered by David Swickhimer in the Enterprise shaft, at a depth of 262 feet, and shortly after ore bodies were found in the Blackhawk, Logan, and Rico-Aspen mines.

The Enterprise mine was sold in 1890 to a Pittsburg company, and the same year saw the advent of the Rio Grande Southern Railway. Vigorous exploitation was continued in various parts of the district until 1895, when mining activity showed signs of abating.

Since 1895 the output of the Pioneer district has decreased. The large bodies of rich "contact" ore have been mined out, and many of the veins have been worked down to a depth at which the ore no longer pays for shipment. Masses of ore often proved to be curiously limited, owing to various conditions that are characteristic of the region and that will presently be described.

The decline in the price of silver has had a depressing effect on this as on other districts where this metal forms a large part of the output. Practically all the important ore bodies formerly

Cable mine and to the experimental treatment of the sphaleritic ore there found.

PRODUCTION.

The total production of the Pioneer mining district can be only roughly estimated. According to the reports of the Director of the Mint, the output from 1879 to the end of 1903 has been about 73,000 ounces of gold and 9,000,000 ounces of silver. The value of the entire product, including the base metals, probably lies somewhere between $8,000,000 and $10,000,000. By far the greater part of this has been silver. Present developments indicate that the district may soon produce considerable zinc and lead.

PRELIMINARY OUTLINE OF THE ORE DEPOSITS.

The ores of the Rico district show unusual variety in their occurrence, as regards both form and genesis. It is proposed in this report to treat the deposits under four general heads, namely: (1) Lodes, (2) blankets, (3) replacements in limestone, and (4) stocks. This is confessedly and obviously a rough grouping for convenience and clearness of treatment, and is not intended as a scientific classification.

Under the first head will be described simple or complex veins, usually nearly vertical, which when they occur in the sedimentary formations cut across the planes of bedding. They are fractures or fissures in the rocks, which have been afterwards filled with ore or valueless vein matter.

Under the second head will be treated various deposits usually more nearly horizontal than vertical, and lying parallel to the planes of bedding or to the surfaces of intrudial sheets of igneous rock. These are the deposits locally known as "contacts." This term, used in a sense that has no necessary connection with its true geological meaning, has unfortunately found its way into literature and has been so universally adopted by the miners that it is difficult to altogether avoid its use. Wherever employed, however, the word will be placed in quotation marks, indicating its true standing as miners' vernacular.

Under the third head will be considered those deposits, often irregular in form, which have resulted from the metasomatic replacement of limestone by ore.

Lastly, under the fourth head, will be noticed a few small ore bodies, often referred to as "chimneys," of which the Johnny Bull is the principal example in this region.

No sharp distinction exists between these various deposits. Lodes of flat dip may pass into bedding faults along weak strata, producing breccias which, when mineralized, are classed as blankets. The mineralization of such a breccia, particularly if the material be calcareous shale, is likely to be largely by metasomatic replacement, producing a deposit closely akin to those resulting from the simple replacement of limestone. Moreover, the ore bodies grouped under the second and third heads are always intimately connected with fissures or lodes which may or may not be themselves productive.

The greater part of the product of the district has come from the blankets. Some of the lodes have proved rich, but their value has invariably fallen below the limit of profitable working at a remarkably shallow depth, which generally bears a constant relation to some overlying blanket with which the lode or lodes connect. Some important

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DISTRIBUTION OF THE ORES.

In all probability more than half of the ore produced in the Rico district has come from Newman Hill. This name is applied to the slopes immediately south and east of Rico, constituting the western flank of Dolores Mountain. Newman Hill may be considered as bounded on the north by Silver Creek, on the west by the Dolores River, on the south by Deadwood Gulch, and on the east by the cliffs formed by the massive bed of limestone characteristic of the medial division of the Hermosa. On this slope, which is deeply covered with surface wash, are the Enterprise, Rico-Aspen, Newman, Union-Carbonate, and other mines, in which the ore occurred partly in lodes *and partly in blankets. Of the latter the principal* one is locally known as the Newman Hill or Enterprise "contact."

Also on the east side of the Dolores River, but north of Silver Creek, is Nigger Baby Hill, a spur of Telescope Mountain. This hill has produced ore since 1879. The ore occurs in oxidized form in lodes, which in their upper portions possess so flat a dip as to constitute essentially blanket deposits.

C. H. C. Hill lies immediately north of Nigger Baby Hill. *It is a landslide area, honeycombed* with workings from which much ore has been taken. The ore, largely oxidized, occurs in blankets, the continuity of which has been greatly broken by landslide movements.

From the three hills mentioned has come the greater part of the Rico ore. There are, however, several important outlying deposits. The most prominent of these is that of the Blackhawk mine, between Silver Creek and Allyn Gulch, where the ore occurs oxidized in a lode and as mineralogical or commercial distinction, and are not necessarily of different age.

The principal minerals occurring as a direct result of the general processes of mineralization are as follows:

Pyrite.—This is by far the most abundant sulphide in the district. Associated with quartz and small amounts of chalcopyrite, sphalerite, and galena, it constitutes the practically worthless filling of most of the lodes. It is found in large blanket-like masses, free from gangue, in C. H. C. Hill. In similar masses, but usually in more *solid condition, it is found as a replacement* of limestone. This is the mode of its occurrence in the Blackhawk mine, where it is frequently associated with fluorite and grades by increase of chalcopyrite and galena into workable ore. Although commonly containing small quantities of silver and gold, the pyrite has hitherto proved too low in grade for successful treatment. Rickard records that the pyrite from the northwesterly lodes in the Enterprise mine usually afforded on assay from 4 to 8 ounces of silver and traces of gold. In the Gold Anchor prospect in Bull Basin a large body of pyrite was found which is said to have indicated, in single assays, as much as 90 ounces of gold per ton, but which as a whole did not pay the cost of extraction.

Galena.—This very important ore mineral occurs abundantly in the Enterprise blanket and in most of the bodies of unoxidized ore that have been *worked in the district. It is always argentiferous,* but apparently does not constitute rich ore unless accompanied by argentite, tetrahedrite (freibergite?), proustite, or polybasite, as is the case in the Newman Hill mines. On the other hand, it nowhere occurs in sufficiently large masses, unless possibly in the Atlantic Cable mine, to be workable for its lead alone. It presents no unusual peculiarities in this region and is, as elsewhere, nearly always accompanied by sphalerite.

Sphalerite.—Zinc blende is an abundant constitwhat are now known as the Atlantic Cable, Aztec, Phoenix, and Yellow Jacket claims. They were unsuccessful, and it was not until 1877 that active prospecting was resumed in the Pioneer district.

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Since 1895 the output of the Pioneer district has decreased. The large bodies of rich "contact" ore have been mined out, and many of the veins have been worked down to a depth at which the ore no longer pays for shipment. Masses of ore often proved to be curiously limited, owing to various conditions that are characteristic of the region and that will presently be described.

The decline in the price of silver has had a depressing effect on this as on other districts where this metal forms a large part of the output. But nearly all the important ore bodies formerly exploited were sufficiently rich to be workable to-day had they not been exhausted. In 1900 the only ore being shipped from the district was an occasional carload taken out by leasers working small areas of unexplored ground in the larger mines.

In 1902 practically all the important mines in the district were consolidated under the name of the United Rico Mines Company and although no material increase of production has yet resulted, the new company has devoted itself with considerable success to the development of the Atlantic no necessary connection with its true geological meaning, has unfortunately found its way into literature and has been so universally adopted by the miners that it is difficult to altogether avoid its use. Wherever employed, however, the word will be placed in quotation marks, indicating its true standing as miners' vernacular.

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The greater part of the product of the district has come from the blankets. Some of the lodes have proved rich, but their value has invariably fallen below the limit of profitable working at a remarkably shallow depth, which generally bears a constant relation to some overlying blanket with which the lode or lodes connect. Some important bodies of ore have also been formed by direct replacement of limestone.

The bulk of the ore has been found in the Carboniferous sedimentary series, particularly that portion of it known as the Hermosa formation. This is nearly equivalent to saying that most of the ore has come from the central portion of the district, in the heart of the dome-like uplift of the Rico Mountains.

The ores consist primarily of galena—often highly argentiferous and associated with rich silver-bearing minerals—sphalerite, and pyrite, several important outlying deposits. The most prominent of these is that of the Blackhawk mine, between Silver Creek and Allyn Gulch, where the ore occurs oxidized in a lode and as sulphide replacement deposits in massive limestone. Another example is the Puzzle mine, on Horse Creek, about three-fourths of a mile from its mouth, where the ore also occurred replacing limestone. The Johnny Bull mine on Johnny Bull Mountain, near the head of Horse Creek, has also produced some ore.

The entire basin of Horse Creek and the eastern slope of Expectation Mountain are dotted with prospects, many of which have produced small quantities of ore, but nearly all are now abandoned.

Another deposit of considerable interest and prospective value is that of the Atlantic Cable mine, on the north side of the town, in which galena, sphalerite, and other minerals occur as replacements of the Devonian limestone.

By reference to the geological map the preponderance of the important ore bodies occurring in the Hermosa, particularly in the lower and middle divisions, will be evident. Near the periphery of the dome, where the Permian, Triassic, and Jurassic sediments now constitute the surface, no large ore bodies have been found. The Johnny Bull, it is true, occurs in Dolores rocks, but the ore body, although at one time giving rise to considerable excitement, proved to be little more than a pocket.

MINERALOGY OF THE ORES.

The ores of the Rico district present few noteworthy or peculiar mineralogical features, and need receive but brief treatment under this head. They may be roughly divided into (1) pyritic ores, usually of very low grade, and (2) argentiferous galena ores, sometimes with rich silver minerals and often containing much sphalerite. The pyritic ores constitute the characteristic vein filling of most of the lodes and occur in many of the blankets and other deposits. The galena ores form the workable ore bodies, deposited under various favorable circumstances of concentration. The two kinds of ore are not capable of sharp [illegible] able for its lead alone. It presents no unusual peculiarities in this region and is, as elsewhere, nearly always accompanied by sphalerite.

Sphalerite.—Zinc blende is an abundant constituent of the rich ores of Newman Hill, which sometimes contain over 15 per cent of zinc. Its common associates in these ores are galena, chalcopyrite, rhodochrosite, and quartz, and it occurs both in the northeasterly lodes and in the blanket. It is also found in massive granular form, associated with a little chalcopyrite, galena, and fluorite, in the Blackhawk mine, where it makes up a considerable part of the large replacement bodies in limestone. In the Atlantic Cable claim it occurs in coarsely crystalline nodular masses, associated with chlorite, specularite, chalcopyrite, and galena, in limestone. This sphalerite is dark brown, while that in the Newman Hill veins is usually rosin colored. It is also abundant in the Sambo mine and in the Bancroft and Lily D. prospects, associated with galena. The occurrence of sphalerite has until recently been purely an objectionable feature in the ores, owing to the penalty attached by the smelters to ores containing over 10 per cent of zinc. But in 1900 experiments were begun to determine the feasibility of working some of the sphalerite ores for zinc. At the present time zinc ore is extracted in commercial quantities from the Atlantic Cable by the United Rico Mines Company and treated in a small stamp mill. The galena is saved on vanners and the sphalerite concentrated by a magnetic separator. Some shipments have been made, but the plant is essentially experimental.

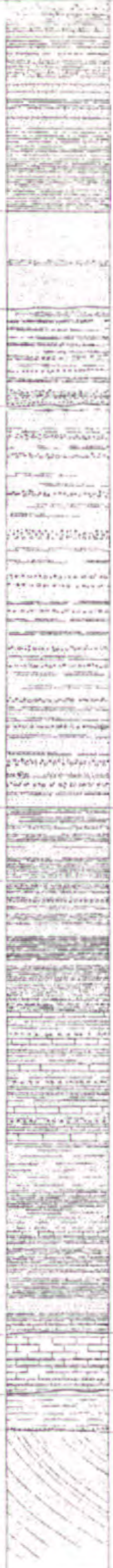
Chalcopyrite.—This mineral is not very abundant in the Rico district, although nearly always present with galena and sphalerite in the workable ores. Associated with pyrite, fluorite, and some finely granular galena and sphalerite, it formed some of the best ore in the Blackhawk replacement bodies, where it often occurred in fine concentric or irregularly curved, narrow bands. It is present in small quantity in the blanket and lode ores of Newman Hill, in the Silver Swan, Aztec, and Atlantic Cable prospects, and in many other lodes and blankets throughout the district.

Tetrahedrite.—Gray copper ore occurs in the

COLUMNAR SECTION

GENERALIZED SECTION FOR THE RICO QUADRANGLE.

SCALE: 1 INCH = 400 FEET.

System.	Series.	Formation Name.	Symbol.	Columnar Section.	Thickness in Feet.	Character of Formations.
CRETACEOUS	UPPER CRETACEOUS	Mancos shale.	Km		1000+	Soft, dark gray, or almost black, carbonaceous clay shale containing thin lenses or concret impure limestone. Embraces the Colorado group and a portion of the Pierre division Montana. Fossils occur more or less abundantly at several horizons.
		Dakota sandstone.	Kd		100-250	Gray or rusty brown quartzose sandstone or quartzite with a variable conglomerate con small chert pebbles at or near the base. Carbonaceous shale partings occur at several le and coal of poor quality is locally present. Indistinct fossil leaves occur sparingly.
JURASSIC		McElmo formation.	Jmc		400-1000	A complex of alternating friable, fine-grained, yellowish or grayish sandstones and shale sandstones are seldom more than 50 feet thick. They often include flakes of grayish shale. The shales are chiefly green in color, but may be pink, dark red, or chocolate Some shale layers are sandy and others highly calcareous. No fossils have been found McElmo strata.
		La Plata sandstone.	Jlp		250-500	Consists principally of two massive, friable, white sandstone beds, with a narrow band o limestone or calcareous shale between them. The sandstones are quartzose, of even gra tinctly cross bedded, and form massive cliffs where exposed. The limestone or calcareou is locally brecciated or recemented. No determinable fossils have been found.
		UNCONFORMITY				
TRIASSIC?		Dolores formation.	Td		400	Sandy marl and fine-grained sandstone and shale of bright-red color with fine limesto glomerate near the base, in which are found teeth of a crocodile (*Belodon*) and of a meg rold dinosaur, with a rare gasteropod shell similar to *viviparus*, indicating the Triassic the formation.
		UNCONFORMITY				
CARBONIFEROUS	PERMIAN?	Cutler formation.	Cc		1600	A complex of bright-red sandstones and lighter red or pinkish grits and conglomerates alter with sandy shales and earthy or sandy limestones of varying shades of red.
	PENNSYLVANIAN	Rico formation.	Cr		300	Dark reddish-brown sandstone and pink grit, with intercalated greenish or reddish shal sandy, fossiliferous limestone.
		Hermosa formation.	Ch		1800-2000	A series of grits, sandstones, shales, and limestones of varying distribution and develop grit and sandstone in massive beds predominate in the middle and upper parts of the se the lower portion consisting of thinner bedded sandstone, shale, and limestone layers. N ous invertebrate fossils occur in shale and limestone.

Formation	Symbol	Thickness	Description
McElmo formation.	Jmc	400–1000	A complex of alternating friable, fine grained, yellowish or grayish sandstones and shales. The sandstones are seldom more than 20 feet thick. They often include flakes of grayish clay or shale. The shales are chiefly green in color, but may be pink, dark red, or chocolate brown. Some shale layers are sandy and others highly calcareous. No fossils have been found in the McElmo strata.
La Plata sandstone.	Jlp	250–500	Consists principally of two massive, friable, white sandstone beds, with a narrow band of dark limestone or calcareous shale between them. The sandstones are quartzose, of even grain, distinctly cross bedded, and form massive cliffs where exposed. The limestone or calcareous shale is locally brecciated or recemented. No determinable fossils have been found.
UNCONFORMITY			
Dolores formation.	Td	400	Sandy marl and fine grained sandstone and shale of bright-red color with fine limestone conglomerate near the base, in which are found teeth of a crocodile (*Belodon*) and of a megalosaurid dinosaur, with a rare gasteropod shell similar to *viviparus*, indicating the Triassic age of the formation.
UNCONFORMITY			
Cutler formation.	Cc	1600	A complex of bright-red sandstones and lighter red or pinkish grits and conglomerates alternating with sandy shales and earthy or sandy limestones of varying shades of red.
Rico formation.	Cr	300	Dark reddish-brown sandstone and pink grit, with intercalated greenish or reddish shale and sandy, fossiliferous limestone.
Hermosa formation.	Ch	1800–2000	A series of grits, sandstones, shales, and limestones of varying distribution and development. Grit and sandstone in massive beds predominate in the middle and upper parts of the section, the lower portion consisting of thinner bedded sandstone, shale, and limestone layers. Numerous invertebrate fossils occur in shale and limestone.
UNCONFORMITY			
Ouray limestone.	DCo	100–300	Dull yellow to buff, compact limestone, lower third shaly with thin quartzites. Abundant fossils indicate Devonian age of lower two-thirds and Mississippian age of upper part.
UNCONFORMITY			
Ignacio quartzite.	Ci	0–250	Quartzite, massive and conglomeratic in lower part, thin bedded with shale and sandy partings in medial zone, succeeded by more massive quartzite. Light gray, pink, or yellow predominates. One shell, *obolus* sp. ?, has been found near the middle of the formation.
UNCONFORMITY			
Uncompahgre formation.	Au		White or smoky quartzite and dark slate, mainly massive, but in a few places alternating in thinner layers. No fossils have been found.

Miss

ALGON

WHITMAN CROSS,
ARTHUR C. SPENCER,
Geologists.

As sedimentary deposits or strata accumulate the younger rest on those that are older, and the relative ages of the deposits may be determined by observing their positions. This relationship holds except in regions of intense disturbance; in such regions sometimes the beds have been reversed, and it is often difficult to determine their relative ages from their positions; then *fossils*, or the remains and imprints of plants and animals, indicate which of two or more formations is the oldest.

Stratified rocks often contain the remains or imprints of plants and animals which, at the time the strata were deposited, lived in the sea or were washed from the land into lakes or seas, or were buried in surficial deposits on the land. Such rocks are called fossiliferous. By studying fossils it has been found that the life of each period of the earth's history was to a great extent different from that of other periods. Only the simpler kinds of marine life existed when the oldest fossiliferous rocks were deposited. From time to time more complex kinds developed, and as the simpler ones lived on in modified forms life became more varied. But during each period there lived peculiar forms, which did not exist in earlier times and have not existed since; these are *characteristic types*, and they define the age of any bed of rock in which they are found. Other types passed on from period to period, and thus linked the systems together, forming a chain of life from the time of the oldest fossiliferous rocks to the present. When two sedimentary formations are remote from each other and it is impossible to observe their relative positions, the characteristic fossil types found in them may determine which was deposited first. Fossil remains found in the strata of different areas, provinces, and continents afford the most important means for combining local histories into a general earth history.

It is often difficult or impossible to determine the age of an igneous formation, but the relative age of such a formation can sometimes be ascertained by observing whether an associated sedimentary formation of known age is cut by the igneous mass or is deposited upon it.

Similarly, the time at which metamorphic rocks were formed from the original masses is sometimes shown by their relations to adjacent formations of known age; but the age recorded on the map is that of the original masses and not of their metamorphism.

Colors and patterns.—Each formation is shown on the map by a distinctive combination of color and pattern, and is labeled by a special letter symbol.

Symbols and colors assigned to the rock systems.

	System.	Series.	Symbol.	Color for sedimentary rocks.
Cenozoic	Quaternary...	Recent .... / Pleistocene....	Q	Brownish-yellow.
	Tertiary	Pliocene....... / Miocene....... / Oligocene...... / Eocene........	T	Yellow ocher.
Mesozoic	Cretaceous...	....	K	Olive-green.
	Jurassic	....	J	Blue green.
	Triassic.......	....	ꞓ	Peacock-blue.
Paleozoic	Carboniferous.	Permian....... / Pennsylvanian / Mississippian..	C	Blue.
	Devonian......	....	D	Blue-gray.
	Silurian.......	....	S	Blue-purple.
	Ordovician....	....	O	Red purple.

planes. Suitable combination patterns are used for metamorphic formations known to be of sedimentary or of igneous origin.

The patterns of each class are printed in various colors. With the patterns of parallel lines, colors are used to indicate age, a particular color being assigned to each system. The symbols by which formations are labeled consist each of two or more letters. If the age of a formation is known the symbol includes the system symbol, which is a capital letter or monogram; otherwise the symbols are composed of small letters. The names of the systems and recognized series, in proper order (from new to old), with the color and symbol assigned to each system, are given in the preceding table.

SURFACE FORMS.

Hills and valleys and all other surface forms have been produced by geologic processes. For example, most valleys are the result of erosion by the streams that flow through them (see fig. 1), and the alluvial plains bordering many streams were built up by the streams; sea cliffs are made by the eroding action of waves, and sand spits are built up by waves. Topographic forms thus constitute part of the record of the history of the earth.

Some forms are produced in the making of deposits and are inseparably connected with them. The hooked spit, shown in fig. 1, is an illustration. To this class belong beaches, alluvial plains, lava streams, drumlins (smooth oval hills composed of till), and moraines (ridges of drift made at the edges of glaciers). Other forms are produced by erosion, and these are, in origin, independent of the associated material. The sea cliff is an illustration; it may be carved from any rock. To this class belong abandoned river channels, glacial furrows, and peneplains. In the making of a stream terrace an alluvial plain is first built and afterwards partly eroded away. The shaping of a marine or lacustrine plain is usually a double process, hills being worn away (*degraded*) and valleys being filled up (*aggraded*).

All parts of the land surface are subject to the action of air, water, and ice, which slowly wear them down, and streams carry the waste material to the sea. As the process depends on the flow of water to the sea, it can not be carried below sea level, and the sea is therefore called the *base-level* of erosion. When a large tract is for a long time undisturbed by uplift or subsidence it is degraded nearly to base-level, and the even surface thus produced is called a *peneplain*. If the tract is afterwards uplifted the peneplain at the top is a record of the former relation of the tract to sea level.

THE VARIOUS GEOLOGIC SHEETS.

Areal geology map.—This map shows the areas occupied by the various formations. On the margin is a *legend*, which is the key to the map. To ascertain the meaning of any colored pattern and its letter symbol the reader should look for that color, pattern, and symbol in the legend, where he will find the name and description of the formation. If it is desired to find any given formation, its name should be sought in the legend and its color and pattern noted, when the areas on the map corresponding in color and pattern may be traced out.

The legend is also a partial statement of the geologic history. In it the formations are arranged in columnar form, grouped primarily according to origin—sedimentary, igneous, and crystalline of unknown origin—and within each group they are placed in the order of age, so far as known, the youngest at the top.

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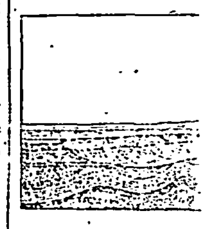

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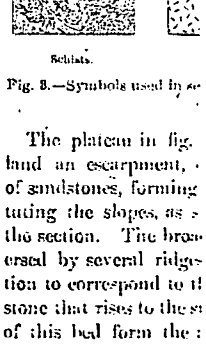

Fig. 3.—Symbols used in se

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shown by their relations to adjacent formations of known age; but the age recorded on the map is that of the original masses and not of their metamorphism.

Colors and patterns.—Each formation is shown on the map by a distinctive combination of color and pattern, and is labeled by a special letter symbol.

Symbols and colors assigned to the rock systems.

	System.	Series.	Symbol.	Color for sedimentary rocks.
Cenozoic	Quaternary	Recent; Pleistocene	Q	Brownish-yellow.
	Tertiary	Pliocene; Miocene; Oligocene; Eocene	T	Yellow ocher.
Mesozoic	Cretaceous		K	Olive-green.
	Jurassic		J	Blue-green.
	Triassic		Ꞧ	Peacock-blue.
Paleozoic	Carboniferous	Permian; Pennsylvanian; Mississippian	C	Blue.
	Devonian		D	Blue-gray.
	Silurian		S	Blue-purple.
	Ordovician		O	Red-purple.
	Cambrian	Saratogan; Acadian; Georgian	Ꞓ	Brick-red.
	Algonkian		A	Brownish-red.
	Archean		Æ	Gray-brown.

Patterns composed of parallel straight lines are used to represent sedimentary formations deposited in the sea or in lakes. Patterns of dots and circles represent alluvial, glacial, and eolian formations. Patterns of triangles and rhombs are used for igneous formations. Metamorphic rocks of unknown origin are represented by short dashes irregularly placed; if the rock is schist the dashes may be arranged in wavy lines parallel to the structure [illegible] level, and the sea is therefore called the *base-level* of erosion. When a large tract is for a long time undisturbed by uplift or subsidence it is degraded nearly to base-level, and the even surface thus produced is called a *peneplain*. If the tract is afterwards uplifted the peneplain at the top is a record of the former relation of the tract to sea level.

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Economic geology map.—This map represents the distribution of useful minerals and rocks, showing their relations to the topographic features and to the geologic formations. The formations which appear on the areal geology map are usually shown on this map by fainter color patterns. The areal geology, thus printed, affords a subdued background upon which the areas of productive formations may be emphasized by strong colors. A mine symbol is printed at each mine or quarry, accompanied by the name of the principal mineral mined or stone quarried. For regions where there are important mining industries or where artesian basins exist special maps are prepared, to show these additional economic features.

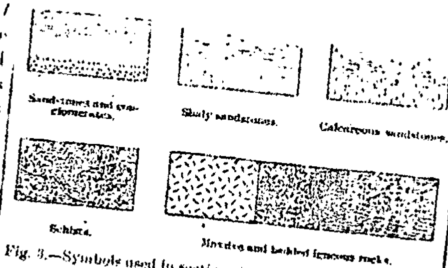

Fig. 3.—Symbols used in sections to represent different kinds of rocks.

The plateau in fig. 2 presents toward the lower land an escarpment, or front, which is made up of sandstones, forming the cliffs, and shales, constituting the slopes, as shown at the extreme left of the section. The broad belt of lower land is traversed by several ridges, which are seen in the section to correspond to the outcrops of a bed of sandstone that rises to the surface. The upturned edges of this bed form the ridges, and the intermediate valleys follow the outcrops of limestone and calcareous shale.

Where the edges of the strata appear at the surface their thickness can be measured and the angles at which they dip below the surface can be observed. Thus their positions underground can be inferred. The direction that the intersection of a bed with a horizontal plane will take is called the *strike*. The inclination of the bed to the horizontal plane, measured at right angles to the strike, is called the *dip*.

Strata are frequently curved in troughs and arches, such as are seen in fig. 2. The arches are called *anticlines* and the troughs *synclines*. But the sandstones, shales, and limestones were deposited beneath the sea in nearly flat sheets; that they are now bent and folded is proof that forces have from time to time caused the earth's surface to wrinkle along certain zones. In places the strata are broken across and the parts have slipped past each other. Such breaks are termed *faults*. Two kinds of faults are shown in fig. 4.

the beginning of deposition of the strata of the second set. During this interval the schists suffered metamorphism; they were the scene of eruptive activity; and they were deeply eroded. The contact between the second and third sets is another unconformity; it marks a time interval between two periods of rock formation.

The section and landscape in fig. 2 are ideal, but they illustrate relations which actually occur. The sections on the structure-section sheet are related to the maps as the section in the figure is related to the landscape. The profile of the surface in the section corresponds to the actual slopes of the ground along the section line, and the depth from the surface of any mineral-producing or water-bearing stratum which appears in the section may be measured by using the scale of the map.

Columnar section sheet.—This sheet contains a concise description of the sedimentary formations which occur in the quadrangle. It presents a summary of the facts relating to the character of the rocks, the thickness of the formations, and the order of accumulation of successive deposits.

The rocks are briefly described, and their characters are indicated in the columnar diagram. The thicknesses of formations are given in figures which state the least and greatest measurements, and the average thickness of each is shown in the column, which is drawn to a scale—usually 1000 feet to 1 inch. The order of accumulation of the sediments is shown in the columnar arrangement—the oldest formation at the bottom, the youngest at the top.

The intervals of time which correspond to events of uplift and degradation and constitute interruptions of deposition are indicated graphically and by the word "unconformity."

CHARLES D. WALCOTT,

Director.

Revised January, 1904.

tions. The arrangement of rocks in the earth is the earth's *structure*, and a section exhibiting this arrangement is called a *structure section*.

The geologist is not limited, however, to the natural and artificial cuttings for his information concerning the earth's structure. Knowing the manner of formation of rocks, and having traced out the relations among the beds on the surface, he can infer their relative positions after they pass beneath the surface, and can draw sections representing the structure of the earth to a considerable depth. Such a section exhibits what would be seen in the side of a cutting many miles long and several thousand feet deep. This is illustrated in the following figure:

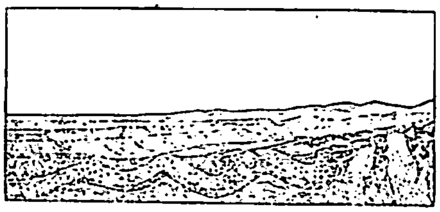

Fig. 2.—Sketch showing a vertical section at the front and a landscape beyond.

The figure represents a landscape which is cut off sharply in the foreground on a vertical plane, so as to show the underground relations of the rocks. The kinds of rock are indicated by appropriate symbols of lines, dots, and dashes. These symbols admit of much variation, but the following are generally used in sections to represent the commoner kinds of rock:

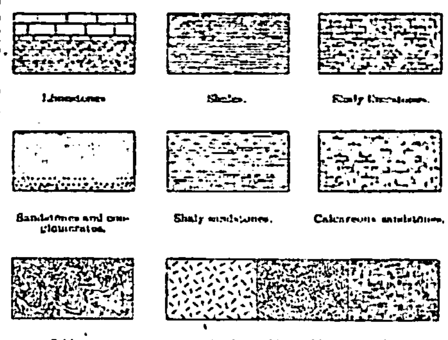

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Fig. 4.—Ideal sections of strata, showing (a) *normal* faults and (b) a *thrust* fault.

inferred. Hence that portion of the section delineates what is probably true but is not known by observation or well-founded inference.

The section in fig. 2 shows three sets of formations, distinguished by their underground relations. The uppermost of these, seen at the left of the section, is a set of sandstones and shales, which lie in a horizontal position. These sedimentary strata are now high above the sea, forming a plateau, and their change of elevation shows that a portion of the earth's mass has been raised from a lower to a higher level. The strata of this set are parallel, a relation which is called *conformable*.

The second set of formations consists of strata which form arches and troughs. These strata were once continuous, but the crests of the arches have been removed by degradation. The beds, like those of the first set, are conformable.

The horizontal strata of the plateau rest upon the upturned, eroded edges of the beds of the second set at the left of the section. The overlying deposits are, from their positions, evidently younger than the underlying formations, and the bending and degradation of the older strata must have occurred between the deposition of the older beds and the accumulation of the younger. When younger rocks thus rest upon an eroded surface of older rocks the relation between the two is an *unconformable* one, and their surface of contact is an *unconformity*.

The third set of formations consists of crystalline schists and igneous rocks. At some period of their history the schists were plicated by pressure and traversed by eruptions of molten rock. But the pressure and intrusion of igneous rocks have not affected the overlying strata of the second set. Thus it is evident that a considerable interval elapsed between the formation of the schists and the beginning of deposition of the strata of the second set. During this interval the schists suffered metamorphism; they were the scene of eruptive activity; and they were deeply eroded. The contact between the second and third sets is another unconformity; it marks a time interval between two periods of rock formation.

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CHARLES D. WALCOTT,

Director.

Revised January, [illegible]

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Geology and Ore Deposits of the Rico District, Colorado

By EDWIN T. McKNIGHT

GEOLOGICAL SURVEY PROFESSIONAL PAPER 723

A discussion of the geology and potential of a famous old silver camp which, under modern mineral technology, became a lead, zinc, and pyrite camp

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1974

GEOLOGY AND ORE DEPOSITS OF THE RICO DISTRICT, COLORADO

By Edwin T. McKnight

ABSTRACT

The Rico district is in the Dolores River valley at the east end of Dolores County in southwestern Colorado. Mining has been actively carried on in the district since 1879. In the early days, silver was the chief product and was mined largely from Newman Hill southeast of the town of Rico. After 1900, the base metals, particularly lead and zinc, mined in other parts of the district, became the major products, though silver remained an important byproduct. The production of the Rico district from 1879 to 1968 has been about 83,000 ounces gold, 14,500,000 ounces silver, 5,600 tons copper, 84,000 tons lead, and 83,000 tons zinc.

Bedrock in the district ranges in age from Precambrian to Permian. The older rocks are exposed in the valley of the Dolores River and its tributary, Silver Creek, near the center of a domal uplift on the east side of a monzonite stock that crops out west of the river at Rico. Precambrian rocks, which are faulted up in a horst block on the eastern prolongation of the monzonite stock, include an earlier complex of greenstone and metadiorite and the later Uncompahgre Quartzite, which is at least 1,000 feet thick. The Uncompahgre Quartzite is overlain in the subsurface by the Ouray Limestone of Devonian age; this is succeeded by the Leadville Limestone (Mississippian), which is the oldest Paleozoic formation that crops out. Combined thickness of the Ouray and Leadville is about 160 feet. Both formations have been metamorphosed by the monzonite intrusive body.

A quartzite from zero to perhaps 80 feet thick has in previous reports on the district been considered as Devonian in age and then Cambrian. Because of structural and erosional complications near the center of the dome, the sequential relations between this quartzite and the Devonian and Mississippian limestones cannot be determined from outcrops. However, drill-hole records indicate that the quartzite overlies the limestones, and fossiliferous chert pebbles found in this quartzite indicate that it cannot be older than Carboniferous. It is here assigned to basal Middle Pennsylvanian, named the Larsen Quartzite, and is considered to be the equivalent of the Molas Formation in other parts of the San Juan region.

The Hermosa Formation, of Middle Pennsylvanian age, is the most widely distributed formation in the mining district. It is about 2,800 feet thick in its best exposed section, and comprises arkoses, sandstones, shales, conglomerates, and interbedded fossiliferous limestones. Although minor limestone and dolomite are scattered through the formation, most of the limestones are concentrated in the middle third. Conglomerates are concentrated in the upper third, and the proportion of red beds increases toward the top of the formation. Lateral variation in the proportions of the different rock types is extreme, and in the southeastern part of the district, clastic strata largely disappear from the middle part of the section to produce a phase of the middle Hermosa that is thinner but is virtually all limestone. The Hermosa Formation is of great economic interest because most of the ore deposits of the district occur in it, particularly in its limestones.

The Hermosa is overlain conformably by the Rico Formation, about 300 feet thick, of Middle and probably Late Pennsylvanian age. The Rico is dominantly a sandstone and arkose sequence, in part conglomeratic, but contains other lithologic types, including limy fossiliferous sandstones in which pelecypods and gastropods are conspicuous. Many of the strata are red beds, though in general the rocks average little, if any, redder than the upper part of the Hermosa. The Rico is transitional on its lithologic and paleoecologic features between the Hermosa and Cutler Formations.

The highest formation exposed in the district is the Cutler Formation, a continental red-bed sequence of Early Permian age. Perhaps as much as 2,800 feet of strata remain, consisting of arkoses, conglomerates, sandstones, shales, and thin impure fresh-water limestones.

At the end of the Mesozoic Era the sedimentary sequence was intruded by sills and dikes of hornblende latite porphyry, one of the sills being as much as 525 feet thick. Apparently at a later stage, the ensemble was intruded by a less silicic stock of monzonite whose present outcrop, west of the Dolores River at Rico, is about 2 miles long and 1 mile wide. Other igneous types include several dikes of alaskite porphyry and a single thin dike of lamprophyre. Pervasive metamorphism of the sedimentary strata extends for 0.4 mile east from the boundary of the stock, and more channelized metamorphism extends to a maximum distance of 1.7 miles.

The dominant structure of the district is a faulted dome centered near the monzonite stock. The Rico mining district is on the northeast, east, and southeast sides of the dome. In the district the major faults near the stock trend generally east-west and border a central faulted horst block of Precambrian rock that has been uplifted at least 6,000 feet. Farther from the stock are two other major faults of diagonal trend. The Princeton fault strikes northeast through the northern part of the mining district and has its upthrow on the northwest side. The Blackhawk fault cuts from northwest to southeast diagonally across the other faults and has its upthrow on the southwest side, toward the horst block. The major faults that dominate the structural pattern of the district are normal faults, and all except the Princeton fault are of steep dip. In addition, numerous bedding faults in the Hermosa Formation have been of considerable economic importance because they commonly afforded access of ore-bearing solutions to sites favorable for ore deposition.

The ore deposits of the district consist of (1) massive sulfide replacement deposits in the limestones of the Her-

mosa Formation; (2) contact-metamorphic deposits of sulfides and iron oxides in limestones chiefly of the Ouray and Leadville Limestones but also of the Hermosa Formation; (3) veins on fractures and small faults in Hermosa sandstones and arkoses; and (4) replacement deposits in residual debris resulting from the solution of a gypsum bed where broken by fissures in the lower Hermosa Formation.

The common sulfide minerals, present in all types of deposits, are pyrite, sphalerite, galena, and chalcopyrite. A silver-bearing mineral of the tetrahedrite-tennantite isomorphous series is widely distributed. Rarer sulfides, generally confined to certain types of deposits, include pyrrhotite, cosalite, tetradymite, and alabandite. Although no longer of significance as ore minerals, several silver minerals accounted for much of the value in the lodes (types 3 and 4 above) mined in Newman Hill before 1900. These include argentite, polybasite, proustite, pearceite, pyrargyrite, and possibly stephanite and argyrodite. Native gold is generally a minor byproduct, but, locally, it has contributed materially to the value of the ore, particularly in some of the rich silver ore formerly mined in Newman Hill.

The common gangue minerals are quartz, fluorite, calcite, dolomite, manganoan siderite, rhodochrosite, rhodonite, and sericite. Barite is of local occurrence. In the contact-metamorphic ores, specularite, magnetite, and chlorite are major gangues. Many other high-temperature silicates are only incidentally associated with the ores.

The massive sulfide replacement deposits in Hermosa limestone (type 1) have been the major source of ores in the 20th century and account for practically all the current production. They are base-metal ores with byproduct silver and gold. Although found in the neighborhood of certain major faults such as the Blackhawk fault, the individual ore bodies are localized on minor breaks. A given ore body is centered on a fracture or minor fault and commonly involves the complete thickness of the limestone bed. Massive pyrite commonly replaces the ore bed adjacent to the feeding fracture, and sphalerite and galena, with variable, though generally sparse chalcopyrite, ring the periphery of the pyrite body. The pyritic masses yielded the sulfur for a large output of sulfuric acid for 9 years, starting in 1955. Some of the pyrite bodies have carried enough copper locally to have been mined as argentiferous copper ores. These replacement ores have been found chiefly in two areas—in CHC Hill in the northern part of the district, and up Silver Creek, roughly 1½ miles east-northeast of Rico, respectively in the foot wall and hanging wall of the Princeton fault.

The contact-metamorphic deposits (type 2) are likewise base-metal ores with byproduct silver and gold. They are less extensive than type 1, occurring only within or on the borders of the Rico townsite. They were exploited chiefly in the 1920's and again during World War II but are not now productive. The base-metal sulfides occur in irregular pods scattered through masses of specularite, magnetite, and chlorite that are centered on fracture zones of small displacement.

The vein deposits (type 3) are widespread in association with the replacement deposits, but are generally too thin to be economically exploitable for base-metal ores. Locally, they may be worked over short stretches where they widen or are followed by development workings. Veins of a different mineralogic type, characterized by an abundance of rich hypogene silver minerals and appreciable gold in addition to the base-metal sulfides, were worked in Newman Hill in the southern part of the district during the 1880's and 1890's but were largely exhausted by 1900. These veins were in a northeast-trending system and were limited to a stratigraphic interval of about 150 feet, in sandstones and arkoses below a capping shaly zone in the lower Hermosa. The veins averaged only 6 inches thick, rarely reaching a thickness of 2 or 3 feet. They pinched and were impoverished in the shales. In general, vein deposits are on faults of small throw, those in Newman Hill having a displacement of less than 10 feet.

The replacement deposits in residual debris resulting from the solution of a gypsum bed (type 4) were also exhausted before 1900. They were closely related to the rich vein deposits in Newman Hill, occurring in horizontal blanket or ribbonlike deposits overlying the apices of the veins. These so-called "contact" deposits were separated from the veins by a shaly interval, .5–20 feet thick, through which extended only minor irregular stringers of the vein material. The contact deposits were from a few inches to 6 feet thick, as much as 40 feet wide centered over the apex of the related vein, and several hundred feet long following the strike of the vein. They occurred not only over the northeasterly veins, but over northwesterly veins that were barren in the vein zone. Mineralogically, the contact deposits were similar to the productive veins, but the ore averaged considerably richer.

INTRODUCTION

LOCATION AND GEOGRAPHY OF DISTRICT

The Rico district is near the east end of Dolores County, Colo. (fig. 1), in the Rico Mountains, a subsidiary group of peaks on the southwest fringe of the San Juan Mountains. Although the peaks are high relative to the plateau country on the west and southwest, they are low relative to the San Juan Mountains. The highest point is Blackhawk Peak, at 12,677 feet, 2½ miles east of the town of Rico. Other peaks that more closely overlook the town, all more than 12,000 feet in altitude, are Dolores Mountain to the southeast, Telescope Mountain to the northeast, and Expectation Mountain across the river to the west. The headwaters of the Dolores River flow south through the heart of the district, and Rico is on its east bank at the confluence of Silver Creek. This creek comes from the northeast between Telescope Mountain and high spurs, including Harts Peak, that extend out from Blackhawk Peak.

The lower slopes of the Rico district are generally mantled by wash, talus, and landslide debris that has slid down from the higher hills. Alluvial fans are extensive at the mouths of the larger creeks. The general effect has been to limit the rock outcrops at lower levels, including much of the mineralized area. The outstanding exception is Sandstone Mountain, on the west side of the river, 2 miles north of Rico. Here, an extensive landslide off the west slope of Telescope Mountain has pushed the Dolores River against its west bank, so oversteepening the slope

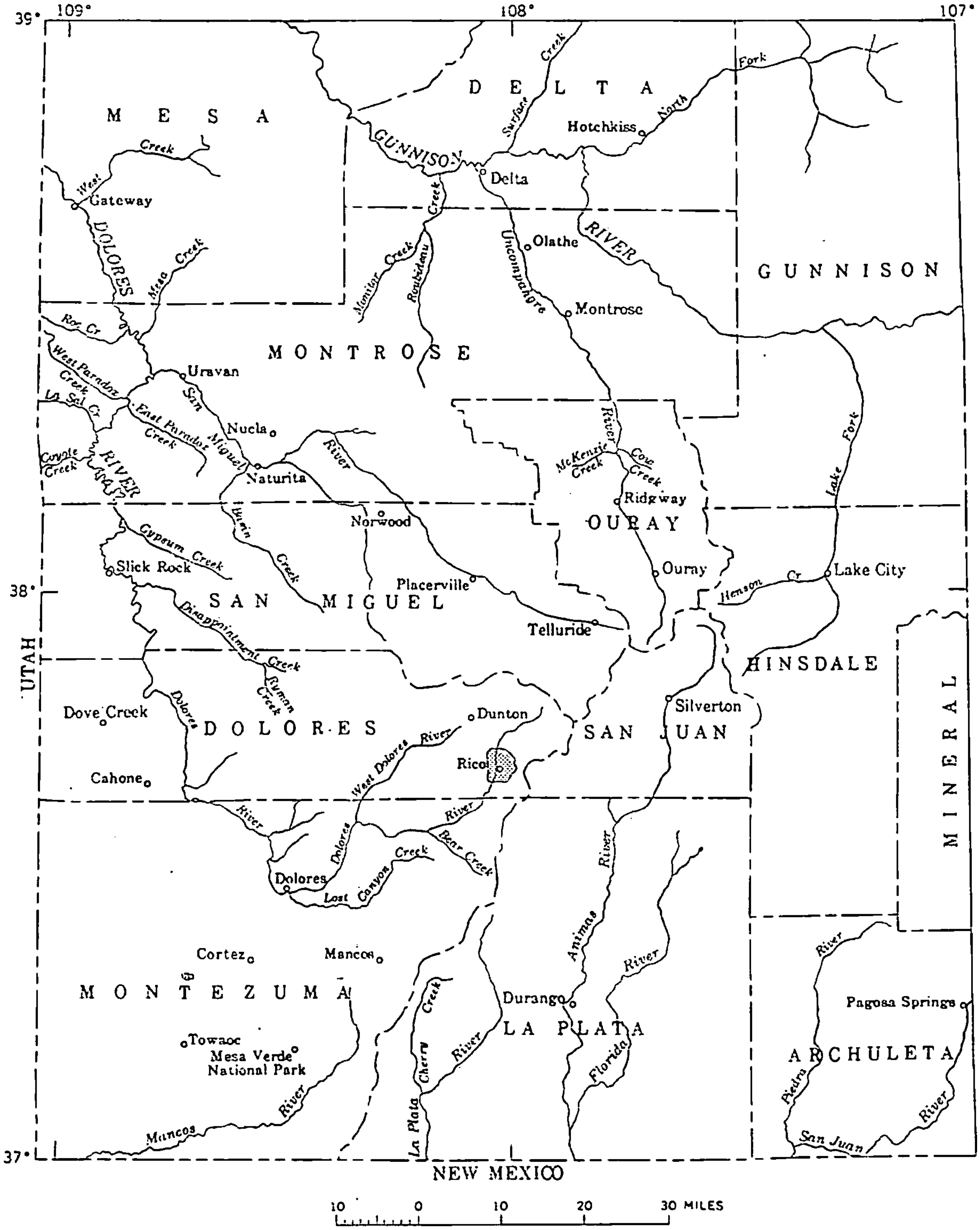

FIGURE 1.—Index map of southwestern Colorado showing location of the Rico district.

that most talus debris on that side has gone into the river and has been distributed in the alluvial material along the valley below. The resultant outcrop face on Sandstone Mountain exposes a stratigraphic section that has been of utmost importance in deciphering the geology of the district. Elsewhere in the district, indifferent outcrops yield only partial sections that can be interpreted only by reference to the Sandstone Mountain section or to underground exposures.

The hills have a discontinuous forest cover in which aspen, Colorado blue spruce, and Englemann spruce at higher levels are dominant types. The timberline is at about 11,500 feet.

Although some mineralized ground is on the west side of the river opposite Rico, the major production from the district has come from mines east of the river. Some of these mines have been in blocks of ground mantled by thick wash and landslide debris. Because of their importance as mining areas, some of these mantled lower slopes of the mountains have been given special names. Thus, CHC Hill is the lower west slope of Telescope Mountain, and Newman Hill is the lower west slope of Dolores Mountain. The major mineral production has come from CHC Hill; from Nigger Baby Hill, which is the long spur that extends southwest from Telescope Mountain and overlooks Rico; from the valley of Silver Creek about 1½ miles northeast of Rico; and from Newman Hill.

In the early production of the district, silver was the major economic product; but upon depletion of the rich silver ores, lead, zinc, and, to a less extent, copper have been the main products, and silver has been an important byproduct. Gold has always been a significant byproduct, and at least one small mine has been worked exclusively for this metal. In 1955 a plant was built for production of sulfuric acid from massive pyrite ores, and in the next 9 years a substantial amount of acid was produced for use in uranium mills of the adjacent Colorado Plateau.

HISTORY

The early history of the Rico mining district has been given by Ransome (1901, p. 238–242) and therefore is only summarized here. The first claim was staked in 1869 on ground along the river at Rico, including parts of what later became the Shamrock, Smuggler, and Riverside claims. In the next 10 years, additional claims were staked within the Rico town area, on Nigger Baby Hill, in the mineralized area up Silver Creek, and in Aztec Gulch. Development work was intermittent, however, and the claims were commonly abandoned on the approach of winter.

In 1879, oxidized silver ores were discovered on Nigger Baby Hill which were rich enough to attract a sharp influx of prospectors into the district. A mining settlement sprang up, civil government was organized, and a post office was established at Rico. In the same year, ore was discovered and shipped from one of the veins in Newman Hill. General activity in the camp increased over the next few years. In 1880 a small smelter was built on the east bank of the Dolores River at the north edge of town to treat the ores from the Grandview mine, but it proved to be short lived. A second smelter was built at the southern end of town, beginning in 1882, and operated as a custom plant for nearly 2 years during 1884–86. Silver production rose to a temporary peak of 193,360 ounces in 1883, but it sagged appreciably in the next 3 years.

In 1887 a prospect shaft on the Enterprise claim, by pure accident, struck the edge of the largest and richest ore body ever found on Newman Hill. This was a blanket ore body of a type that proved to be very productive of rich silver ore during the next few years, as further ore bodies were explored and opened in the extension of mining from this initial discovery. The Enterprise success stimulated development throughout the camp, and within the next few years ore had been developed in all the mineralized areas that are now known, including CHC Hill. The Rio Grande Southern Railroad Co. completed a narrow-gage line into the camp in 1890, and within a short time spur lines were operating up Silver Creek and to the portal of the Enterprise Group tunnel.

The all-time peak of silver production was reached in 1893, 2,675,238 ounces, of which the mines in Newman Hill, particularly the Enterprise mine, contributed the largest share. The drop in silver prices during the 1890's, and particularly the famous silver panic in mid-1893, affected Rico as it did all other western mining camps, and the production fell sharply in the next few years. Yet the fundamental cause for the decline as a silver camp was depletion of the rich silver ores. By the time of the Ransome (1901) report, the Newman Hill mines were largely exhausted of all except low-grade base-metal ores.

In the early 1900's, other parts of the district became relatively more productive, and by 1905 for the first time the combined values of lead and zinc produced in the district exceeded that of silver. Activity in the district waxed and waned with the economics of mining during the next several years, but there was substantial development and production each year. The demands for base metals before and during World War I stimulated the mining of base-metal ores, particularly in CHC Hill and in the mineralized area up Silver Creek. However, peaks of production generally depended on the fortunes of ore discovery. A temporary peak for base metals was reached in 1913 when the district produced 400 tons of copper, 1,540 tons of lead, and 1,300 tons of zinc. Although the output of lead and zinc fluctuated at a lower level in the next few years, the all-time peak production of copper, 516 tons, was reached 2 years later, principally from the Mountain Spring-Wellington mine of the Rico-Wellington Mining Co.

in CHC Hill. Mining economic conditions began to deteriorate during the last year of the war, and production reached a low ebb by 1921.

In the mid-1920's the mining industry at Rico revived, chiefly through advances in the metallurgical industry. Perfection of the flotation process in the previous decade had made attractive such complex sulfide ores as prevail at Rico, and the mine operators were, for the first time, able to realize a fair profit on the zinc content of their ores instead of being penalized for it as in past years. At first, the ores were shipped to new custom flotation mills in the Salt Lake area, Utah, but in 1926 a 250-ton custom mill was built at Rico by the International Smelting Co. (subsidiary of Anaconda Mining Co.), and for nearly 2 years most of the output of the district was concentrated in this mill. The chief producing companies included the Rico Argentine Mining Co., working the mineralized area up Silver Creek on the south side of the creek; the Falcon Lead Co., working the Yellow Jacket mine and other properties on Nigger Baby Hill; the Rico Mining & Reduction Co. and (after May 1927) its successor, the St. Louis Smelting & Refining Co., working CHC Hill, the Silver Swan mine below Rico, and a small part of the mineralized area along Silver Creek; the Pelleyre Mining & Milling Co. (subsidiary of International Smelting Co.), working the Shamrock and several other properties in the district; Union Carbonate Mines, Inc., working the Union Carbonate mine; and the Rico Enterprise Mining Co., working the Pro Patria and Revenue mines. The all-time peak of production for base metals was made in 1927 when the district output was 5,308 tons of zinc, 4,994 tons of lead, and 65 tons of copper. The mining boom was, however, relatively short lived. The custom mill at Rico operated only from October 1926 to July 1928, when it shut down permanently. Ore that continued to be produced for a time was shipped again to the custom mills at Salt Lake.

In 1929 mining at Rico was hit by the Depression, and by 1932, production had ceased. The St. Louis Smelting & Refining Co. drove its St. Louis tunnel and crosscut extensions into the east bank of the Dolores River under CHC Hill during the depth of the Depression (1930–32), but failed to reach the Mississippian and Devonian limestones in which deep replacement ores were prospective targets. Mining was resumed on a relatively small scale in 1934, and production from several mines fluctuated over the next few years.

In September 1939, the Rico Argentine Mining Co. finished a new 135-ton flotation mill and began a period of steady production that brought a degree of stability to the mining industry at Rico. This company was the major producer during World War II. The Van Winkle shaft was sunk on the east edge of town in 1942, and for several years supplied a large share of the Rico Argentine production. The company has maintained steady production, though not always at mill capacity, to the present day except for two periods, May 1949 to July 1950, and June 1957 to some time in 1959, when low base-metal prices made the operation uneconomic. The long crosscut from the St. Louis tunnel to the Argentine shaft on Silver Creek was finished in 1955, lowering the water level in the Silver Creek mine workings by about 450 feet and draining a large block of mineralized ground. At present, the company controls most of the mining properties from which the major past production of the district has come. Its mill capacity (1969) is rated at 150 tons per day.

In September 1955, the Rico Argentine Mining Co. completed and put in operation a plant for the production of sulfuric acid from pyrite. The acid was sold to several uranium mills operating in the adjacent part of the Colorado Plateau. The acid plant ran for 9 years, until a cutback in the uranium program destroyed the market for the acid. The plant was put on a standby basis in October 1964. Much of the acid production came at a period of low base-metal prices, when the entire mining facilities could readily be diverted to the mining of pyrite.

TRANSPORTATION FACILITIES

The narrow-gage railroad completed through Rico by the Rio Grande Southern Railroad Company in 1890 served the district for 60 years. In its later days, locomotive power was supplied by various models of converted automobile gasoline engines. Eventually, freight from the mining industry at Rico and Telluride was not enough to sustain the railroad, and it was finally abandoned as uneconomic in 1951. Since then, mining supplies have been brought in and concentrates taken out by truck. At present (1969), all concentrates are trucked to the Denver and Rio Grande Western Railroad line at Ridgway, Colo., where they are loaded into freight cars and shipped to the Bunker Hill Co. reduction plants at Kellogg, Idaho.

PRODUCTION

Table 1 gives the production of precious and base metals from the Rico district from 1879–1968.

Between September 1955 and October 1964, the acid plant produced 316,108 tons of commercial sulfuric acid, 100 percent basis. In the first year and a quarter, pyritic tailings from the lead-zinc mill

TABLE 1.—*Gold, silver, copper, lead, and zinc produced in the Rico district, 1879–1968*

[Figures derived by subtracting from the production of Dolores County that of the Lone Cone district, which is the only other metal-producing district of record (1896–1941) in the county. Lone Cone production for 1896–1903 estimated (gold and silver only), for later years from unpublished statistical charts furnished by the U.S. Bur. Mines. Production of Dolores County for 1879–1923 from Henderson (1926, p. 117); for 1924–31, from annual volumes of U.S. Bur. Mines Mineral Resources of the United States; for 1932–62, from annual volumes of U.S. Bur. Mines Minerals Yearbook; for 1963–68, from unpublished statistics furnished by U.S. Bur. Mines. Compilation for Dolores County by Robert C. Luedke, U.S. Geol. Survey]

Year	Lode gold		Silver		Copper		Lead		Zinc		Total value
	Fine ounces	Value	Fine ounces	Value	Short tons	Value	Short tons	Value	Short tons	Value	
1879	73	$1,500	7,734	$8,662	2	$800	5	$410	----	----	$11,372
1880	169	3,500	30,938	35,579	14	6,206	50	5,000	----	----	50,285
1881	242	5,000	69,510	78,659	22	8,008	100	9,600	----	----	101,267
1882	484	10,000	85,078	96,989	27	10,314	100	9,800	----	----	127,103
1883	242	5,000	193,360	214,630	50	16,500	100	8,600	----	----	244,730
1884	73	1,500	54,141	60,097	--	----	76	5,624	----	----	67,221
1885	193	4,000	70,000	74,900	--	----	50	3,900	----	----	82,800
1886	414	8,561	75,836	75,078	--	----	306	36,432	----	----	120,071
1887	471	9,743	118,262	115,897	17	4,692	500	45,000	----	----	175,332
1888	845	17,470	123,852	116,421	--	----	500	44,000	----	----	177,891
1889	3,765	77,825	618,615	581,498	--	----	1,000	78,000	----	----	737,323
1890	7,561	156,297	843,785	891,224	--	----	1,000	90,000	----	----	1,137,521
1891	5,932	122,631	699,883	692,880	--	----	466	40,047	----	----	855,557
1892	11,401	235,669	1,285,179	1,118,106	7	1,513	1,542	123,327	----	----	1,478,615
1893	21,387	442,105	2,675,238	2,086,686	5	1,080	2,250	166,500	----	----	2,696,371
1894	9,318	192,626	1,163,325	726,595	15	2,850	1,000	66,000	----	----	988,071
1895	2,542	52,552	399,283	259,534	32	6,864	157	10,042	----	----	328,992
1896	216	4,465	221,393	150,547	--	----	550	33,000	15	$1,170	189,182
1897	603	12,464	104,901	62,941	20	4,758	547	39,378	----	----	119,541
1898	1,771	36,607	338,346	199,624	75	18,556	343	26,091	200	18,400	299,278
1899	1,234	25,508	157,052	94,231	22	7,611	1,023	92,080	50	5,800	225,230
1900	925	19,120	84,318	52,227	18	5,978	105	9,257	110	9,680	96,262
1901	179	3,700	66,632	39,979	7	2,189	184	15,783	125	10,250	71,901
1902	296	6,118	46,311	24,545	8	1,837	194	15,941	124	11,937	60,378
1903	293	6,056	45,096	24,352	74	20,220	72	6,024	----	----	56,652
1904	657	13,578	44,432	26,251	13	3,250	91	7,793	9	928	51,800
1905	206	4,250	29,496	18,275	60	18,692	420	39,495	278	32,820	113,532
1906	455	9,398	34,290	23,317	100	38,480	59	6,739	442	53,896	131,830
1907	132	2,734	20,317	13,409	50	19,899	27	2,801	----	----	88,933
1908	588	12,155	85,310	45,214	21	5,488	474	39,772	255	23,932	126,561
1909	514	10,641	64,375	33,475	22	5,621	230	19,756	84	9,049	78,542
1910	320	6,616	49,795	26,889	48	12,113	62	5,479	44	4,698	55,795
1911	23	475	30,842	16,346	2	373	350	31,476	263	29,944	78,614
1912	64	1,313	68,794	42,309	345	113,709	604	54,339	406	56,030	267,700
1913	306	6,333	153,111	92,479	400	124,057	1,538	135,332	1,298	145,389	503,590
1914	317	6,542	80,844	44,707	175	46,576	246	19,156	183	18,694	135,675
1915	524	10,828	122,664	62,190	516	180,670	134	12,593	18	4,456	270,737
1916	269	5,557	71,578	47,098	210	103,197	294	40,551	91	24,429	220,832
1917	252	5,213	88,222	72,695	260	141,937	886	152,411	851	173,538	545,794
1918	145	2,991	54,240	54,240	309	152,649	259	36,735	331	60,174	306,789
1919	122	2,517	35,084	39,294	132	49,284	49	5,231	34	4,893	101,219
1920	85	1,759	28,556	31,126	3	1,252	396	61,752	115	18,619	114,508
1921	68	1,401	10,524	10,524	1	96	9	838	----	----	12,859
1922	54	1,126	25,423	25,423	12	3,252	44	4,796	----	----	34,597
1923	56	1,154	33,471	27,447	28	8,336	81	11,331	69	9,384	57,652
1924	8	178	8,709	5,835	6	1,545	89	14,167	11	1,417	23,142
1925	83	1,722	37,994	26,368	23	6,674	908	157,975	1,053	160,056	352,795
1926	189	3,902	92,040	57,433	54	15,036	2,917	466,760	2,981	447,150	990,281
1927	411	8,488	173,395	98,315	65	17,161	4,994	629,230	5,308	679,360	1,432,554
1928	1,044	21,585	350,653	205,132	444	127,730	4,526	524,964	4,646	566,812	1,446,223
1929	532	11,016	268,783	143,261	164	57,596	3,530	444,739	2,952	389,730	1,046,342
1930	386	7,975	80,683	31,063	155	40,170	678	67,750	695	57,120	204,078
1931	34	697	1,648	478	1	182	35	2,553	41	3,116	7,026
1932	5	95	2	1	--	----	----	----	----	----	96
1933	40	817	4,820	1,687	1	51	3	222	----	----	2,777
1934	352	12,287	49,302	31,872	10	1,584	119	8,843	107	9,202	63,788
1935	655	22,944	71,040	51,060	13	2,075	140	11,220	142	12,452	99,751
1936	309	10,801	20,031	15,514	7	1,288	119	10,948	139	13,950	52,501
1937	188	6,566	13,086	10,122	7	1,694	125	14,697	136	17,680	50,759
1938	34	1,200	4,642	3,001	2	333	29	2,622	30	2,880	10,036
1939	121	4,235	41,356	28,072	65	13,416	762	70,688	867	90,168	206,579
1940	275	9,625	153,990	109,504	482	109,045	1,928	192,760	2,607	328,482	749,406
1941	102	3,570	112,715	80,153	62	14,632	2,525	287,833	3,004	450,600	836,788
1942	119	4,165	110,918	78,875	35	8,482	2,282	305,795	2,764	514,178	911,495
1943	127	4,445	145,021	103,126	72	18,785	2,566	384,000	3,652	788,832	1,300,088
1944	141	4,935	121,701	86,607	118	31,995	2,826	452,240	4,557	1,038,996	1,614,733
1945	157	5,495	152,256	108,278	86	23,220	2,440	419,680	3,920	901,600	1,458,273
1946	136	4,760	173,297	140,024	112	36,126	2,176	474,259	3,435	838,140	1,493,309
1947	104	3,640	124,199	112,400	109	45,591	2,042	588,168	3,433	830,883	1,580,682
1948	108	3,780	132,312	119,749	74	32,116	2,430	869,940	3,180	845,880	1,871,465
1949	79	2,765	80,032	72,433	33	13,002	1,388	438,608	1,354	335,792	862,600
1950	71	2,485	72,735	65,829	35	14,560	1,138	307,260	1,366	387,660	777,794
1951	220	7,700	131,912	119,387	51	24,684	2,231	771,926	2,527	919,828	1,843,525
1952	128	4,480	127,446	115,345	73	35,332	2,230	718,060	2,734	907,688	1,780,905
1953	95	3,325	103,908	94,042	18	10,332	1,871	490,202	2,634	605,820	1,203,721
1954	147	5,145	118,621	107,358	11	6,490	2,177	596,498	2,896	625,536	1,341,027
1955	156	5,460	114,392	103,531	5	3,730	2,202	656,106	2,571	632,466	1,401,383
1956	179	6,265	97,181	87,954	6	5,270	1,858	583,396	1,668	457,114	1,139,999
1957	13	455	8,829	7,991	1	181	201	57,516	159	36,958	103,100
1958	----	----	----	----	--	----	----	----	----	----	----
1959	18	630	17,562	15,894	3	1,750	325	74,865	362	83,214	176,353
1960	84	2,940	81,593	73,846	10	6,388	1,377	322,183	961	248,041	653,398
1961	63	2,205	49,091	45,384	7	4,290	833	171,444	947	217,695	441,018
1962	46	1,610	31,523	34,202	5	2,895	782	143,952	681	156,722	339,381
1963	25	875	30,112	38,517	5	3,326	542	117,050	484	111,320	271,088
1964	22	770	21,939	28,367	3	2,184	484	126,677	498	135,443	293,441
1965	68	2,380	74,129	95,840	18	12,850	1,457	454,521	1,456	425,137	990,737
1966	68	2,380	54,533	70,511	26	18,664	1,100	335,220	1,147	332,674	759,449
1967	57	1,995	71,397	110,650	20	15,176	1,449	405,804	1,708	472,849	1,006,474
1968	59	2,316	77,129	165,411	18	16,023	1,461	386,028	1,610	434,808	1,003,586
Total	83,045	1,781,702	14,513,288	11,735,029	5,637	1,951,561	83,847	15,228,650	82,717	17,243,559	47,940,501

altitude 9,742 feet and bears generally east-southeast, nearly parallel to the strikes of the Blackhawk fault and of the strata. Its portal is 25 feet within the hanging wall of the Blackhawk fault just southeast of the Last Chance fault junction, and the entry tunnel merges onto the fault 250 feet from the portal. The mineralized ground is in the hanging wall to the northeast. At 340 feet from the portal, the main tunnel crosscuts over to the northeast to follow the Alleghany fissure, which is parallel to and about 200 feet from the Blackhawk fault; but farther along the tunnel, a branch crosscuts back to the Blackhawk fault and drifts along a small break in its immediate hanging wall (pl. 3*A*). Maximum penetration of the Log Cabin tunnel is about 1,400 feet into the hill.

The limestone beds mineralized include the H, I–J, K, and L beds at the top of the middle Hermosa. The distribution of the beds at the Log Cabin level is shown on plate 3*A*. Most of the stopes at and above the Log Cabin level are between the Alleghany and Blackhawk breaks and within 210 feet of the latter, but those on the H and I–J beds follow eastward diagonally down the bedding to the Argentine level. As the Blackhawk fault also dips in this direction, though at a steeper angle, the distance between the fault and the outer edges of mineralized ground does not greatly increase. In a part of the ground, the stopes in the four ore beds are roughly superposed, indicating a common feeder system among the cross fractures. No single fracture can be mapped to account for this, but a system of connecting fissures are present. The ore solutions were thus able to travel from one to the other in a general zone of fracturing. The stope in the H bed, extending from below the Argentine level at the bottom to above the Log Cabin level at the top, is 420 feet long and a maximum of 60 feet wide, as projected on a horizontal plane. The stope in the I–J bed bottoms at the Argentine level and extends up through the Log Cabin level to somewhat above the Carbonate tunnel whose caved portal is 109 feet above the Log Cabin portal. This stope (as projected) is 580 feet long and a maximum of 150 feet wide, though averaging 60–80 feet. The stope in the K bed, which is thin, bottoms between the Argentine and Log Cabin levels and extends through the Log Cabin level to some distance above the Smith tunnel, breaking through to the surface at its upper end. It has a projected length of 500 feet and a width that is generally less than 40 feet, but attains 90 feet at the upper end. A persistent bedding fault at the top of the K bed may have furnished the structural setting for the mineralization. In the L bed, part of the stoping is superposed on that in the lower beds, but there is extensive stoping which is independent of that in lower beds. None of the stopes in the L bed extend below the Log Cabin level. The largest stope, superposed at the west end and running more nearly parallel to the strike of the bedding, is 580 feet long and maximum 120 feet wide.

The Alleghany fissure, so conspicuous on the map of the Log Cabin level (pl. 3*A*), may have been a mineralizing fissure for all the traversed beds (H to L) adjacent to its northwest extent along the level, but it failed to mineralize the L bed for a long stretch near the southeast end of the level. The fissure is a fault of reverse throw and small displacement. It dips mostly southwest at 60°–80°, with the southwest side up 5–18 feet as measured on the level. The fissure contains 2–8 inches of gouge, pyrite, calcite, and, locally, some sphalerite.

BLACKSMITH TUNNEL

Although the Blacksmith tunnel has not been accessible during the fieldwork for the present report, it is of special interest because of the stratigraphic units involved in the mineralization. The tunnel portal is S. 56° E., 530 feet from the Log Cabin portal, and about 267 feet higher. As interpreted from cross section and stope maps prepared by W. R. Landwehr, geologist of the American Smelting & Refining Co., the tunnel provided access to stopes in the two lowest limestone beds of the upper Hermosa within 200 feet of the Blackhawk fault. The stratigraphic units mineralized are Nos. 27 and 29 of the composite section (see p. 24), whose bases are about 126 and 202 feet, respectively, above the base of the upper Hermosa. The lower stope trends nearly parallel to the strike of the bedding and is 185 feet long and 40 feet wide maximum. The upper one, which is really two closely juxtaposed stopes of very irregular outline, shows an overall projected length of nearly 200 feet down the dip of the bedding starting from the Blackhawk fault and a maximum width of 120 feet. These stopes are not superposed, nor do they overlie stopes in limestones of the middle Hermosa. Lower limestone strata at the top of the middle Hermosa are pinched out against the fault below the level of the Blacksmith tunnel.

ARGENTINE TUNNEL

The Argentine tunnel is in the hanging-wall block of the Blackhawk fault northeast of the Log Cabin tunnel and about 160 feet lower, its portal having an altitude of about 9,588 feet. It trends in a general southeasterly direction nearly parallel to the strike of the bedding and shows an overall penetration of about 2,400 feet into the hill. In the first 930 feet are several prongs that are more or less interconnecting, but beyond that, the working is a linear tunnel from which a few crosscuts have been extended (pl. 3*B*).

Some of the prongs of the tunnel in the first 930 feet intersect the lower ends of two of the large stopes previously discussed for the Log Cabin level, namely, those in the H and I–J beds. At their lower ends the outer edges of these stopes are, respectively, 160 and 220 feet from the Blackhawk fault, as measured on the level. Much of the ore from stoping in the K bed between the Argentine and Log Cabin levels was also taken out through these prongs of the tunnel. The Argentine workings in this block also intersect mineralized ground in a lower bed, the E bed, which pinches out against the Blackhawk fault well below the Log Cabin level. The stoped ground in the E bed is small and is characterized by an abundance of garnet. Plate 3*B* shows the distribution of the limestone beds on the Argentine level.

The Blackhawk fault has been probed by crosscuts at four places (pl. 3*B*), but no workings penetrate more than 40 feet into the lower Hermosa strata of the footwall.

The other dominant structure revealed on the tunnel level is the Honduras fault, which is a reverse fault trending slightly south of east and dropping the strata on the north side about 140 feet. Although the displacement is in the same direction as that of the Blackhawk fault, the dip is in the opposite direction, mostly 70°–80° S. The fault break is occupied by 2–8 feet but commonly about 5 feet of gouge, quartz, and pyrite. The I–J bed limestone unit in the dropped block has been mineralized and stoped at a level between the Argentine and underlying Blaine level. This "4 bed" stope,[1] though irregular in shape, is about 250 feet long in a direction nearly perpendicular to the fault and 90 feet wide at the maximum. However, another prong of the stope 10–20 feet wide follows along the north side of the fault for a distance of 140 feet west from the main stope. Mineralization of this latter prong can be attributed to shattering along the hanging-wall side of the Honduras fault. The main northward-trending prong lies along the northwest side of the Rico Argentine dike; shattering of the limestone adjacent to the dike probably furnished the channelways for introduction of the ore solutions. However, the northern part of the stope is also traversed by a small fault dipping westward at 45°–60° and dropping the strata on the west about 15 feet. Updip and a little farther north this fault was responsible for a replacement blanket of sulfide ore at a higher stratigraphic level in the middle tunnel of the Rico Consolidated mine (see p. 84). The remote end of the "4 bed" stope is about 450 feet from the Blackhawk fault. The stope is of mineralogic interest in that cosalite and huebnerite, rare minerals for the district, are present in the massive pyritic replacement ore.

In the ground explored by the deeper parts of the Argentine tunnel, mineralization was not so extensive as in the first 930 feet. The deeper part of the tunnel follows the general course of the Alleghany fissure. Over much of the Argentine level this fissure is 60–120 feet northeast of the Blackhawk fault, striking nearly parallel to it but dipping generally in the opposite direction (southwest) at 60°–80°, except near the southeast end of the mine where it steepens through verticality and farther southeast dips parallel to the Blackhawk fault. Displacement on this level amounts to a few tens of feet, down on the northeast. Although the northwest end of the Alleghany fissure was apparently an important part of the feeder system for the mineralization in the front part of the mine, it was a less effective mineralizer farther southeast. Nevertheless, there are some stopes that are obviously related to it. Where it intersects the I–J bed above the Argentine level in the 3-compartment raise to the Log Cabin level, at 14,060N, 14,690E (pl. 3*B*), a stope extends southeast for at least 180 feet. The stope is about 10 feet wide, and narrowly confined to the intersection of the fissure with the ore bed which here strikes nearly parallel to the fissure and dips about 45° NE. This stope is about 150 feet from the Blackhawk fault.

At 250 feet from the southeast end of the tunnel where the Alleghany fissure dips northeast, its hanging wall contains the 138 stope which is a pyritic copper stope in the L bed, running eastward diagonally down the dip of the bedding to the Blaine level. Owing to the gradual convergence of the Alleghany fissure and Blackhawk fault at this end of the mine, the 138 stope is also only a short distance in the hanging wall of the Blackhawk fault, 60 feet from the fault at the Argentine level and 120 feet from the fault at the Blaine level. The stope is 300 feet long as projected on a horizontal plane and a maximum of 70 feet wide. Slickensides in the stope indicate that faulting along the bedding was an important structural preliminary to the mineralization. The stope is reported to have yielded 2 ounces of silver for each percent of copper.

[1] The stope is labeled "4 bed" stope on mining company maps, but this is a misidentification, as it is really in the 2 bed of company terminology: see the composite section, p. 24.

A crosscut to the northeast near the end of the Argentine tunnel intersects a bedding fault near and at the top of the L bed. There has been some stoping of this bed on and below the fault and updip from the level, but the amount of ore obtained was not great. The mineralized segment of the ore bed is bounded laterally by crosscutting porphyry dikes, one of which was offset by the bedding fault. Stoped ground in this block is a maximum of 250 feet from the Blackhawk fault.

RICO CONSOLIDATED TUNNELS

The three tunnels of the Rico Consolidated mine are about 400 feet northeast of the Argentine portal. The altitude of the upper tunnel portal is 9,629 feet, and of the middle portal, about 9,563 feet. Both portals are caved; but the middle tunnel is accessible from the Argentine workings, and the upper tunnel is accessible from the middle tunnel. The lower tunnel is caved.

The tunnels enter the hill in an irregular, but generally, south-southeasterly direction. The middle tunnel at about 600 feet from the portal hits the Honduras fault and drifts east on it for 250 feet (pl. 3*B*). The strata traversed are chiefly the basal part of the upper Hermosa. However, the L bed, at the top of the middle Hermosa, is intersected 80 feet before the Honduras fault is reached and is also cut on the south side of the Honduras fault in the drift to the east. It is not mineralized.

The only mineralized ground is in the front part of the mine, in the lowest good limestone bed of the upper Hermosa, unit 27 of the composite section (see p. 24). Most of the mineralization is adjacent to the 210 Drift fault near its northeast end, and chiefly on its south or upthrown side. In contrast to its general vertical attitude elsewhere, the fault here dips 70° S., and hence shows reverse displacement amounting to about 20 feet. A large stope 20–30 feet wide plunges eastward diagonally down the dip of the bed at its intersection with the fault, and a pyritized blanket of the ore bed about 100 feet wide extends south from the fault diagonally up the bedding dip and nearly perpendicular to the fault. This pyrite blanket is traversed lengthwise by the small cross fault, dipping 46°–60° W., that is followed for several hundred feet by the main tunnel. The fault drops the strata on the west about 17 feet and also displaces the Rico Argentine dike (pl. 3*B*). It is undoubtedly the feeder for the sulfide mineralization in the pyritic blanket. The center of this blanket is too low grade to be minable, but ore stopes were developed along its two sides. The larger stope on the east side is about 160 feet long as projected on a horizontal plane and is 15–20 feet wide. A bedding fault at the top of the ore bed doubtless facilitated the introduction of the ore solutions. The presence of hydrated iron oxides and green copper stains in the walls of the stopes suggests that the ore taken out was partly oxidized.

An additional small stope was opened along the northwest side of the Rico Argentine porphyry dike. This stope was not completely mapped, so its length is not available. It has a maximum width of 20 feet but is for the most part only 6 or 7 feet wide.

The upper tunnel explores the ore bed at a higher level where it is massively pyritized, but there was only negligible stoping on this level, along the edge of the porphyry dike. The tunnel crosses the vertical Honduras fault at 590 feet from its portal and extends 155 feet farther into the footwall.

The stopes on the middle tunnel level are 600–800 feet from the Blackhawk fault and 260–460 feet from the Honduras fault. It appears obvious that the 210 Drift fault, which in most places is a tight poorly mineralized fissure, has acted as a mineralizing channel in this place, though the eventual trunk channel may well have been the Blackhawk fault.

JAMES G. BLAINE TUNNEL

The Blaine tunnel enters the southeast bank of Silver Creek just above creek level at an altitude of about 9,336 feet, 400 feet east of the Rico Argentine mill. It starts on the southwest side of the Blackhawk fault in the thick shale unit just above the H bed of the middle Hermosa and follows a general east-southeast course until it intersects the Blackhawk fault, 410 feet from the portal. From here, the course is southeast along the Blackhawk fault, though the fault is not followed in detail (pl. 3*C*). In the first 1,700 feet from the portal there is, in addition to the main haulage tunnel, an intricate system of drifts, crosscuts, and stopes that develop the blocks of ground on both sides of the fault, but particularly the northeast, or hanging-wall, side. Beyond 1,700 feet from the portal (measured in a straight line), the chief working is the main haulage tunnel, but numerous tributary crosscuts explore adjacent ground. The total straight-line length of the tunnel is 3,750 feet, though the actual length is somewhat greater because of deviations in course. In the last 1,250 feet, the main tunnel diverges from the Blackhawk fault into its hanging wall, though crosscuts to the fault indicate that the tunnel is nowhere more than 125 feet northeast from the fault.

The structure in the front 1,700 feet of the Blaine workings is greatly complicated by the junction of the Honduras and Blackhawk faults on this level. Although both faults drop the strata on the north

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GEOLOGY OF THE RICO MOUNTAINS, COLORADO

BY

WHITMAN CROSS and ARTHUR COE SPENCER

GEOLOGY OF THE RICO MOUNTAINS, COLORADO.

By Whitman Cross and Arthur Coe Spencer.

PREFACE.

By Whitman Cross.

The Rico Mountains, the area discussed in the accompanying report, are situated in southwestern Colorado near the headwaters of the Dolores River. The summits of this compact and rather isolated group lie within an oval area about 7 miles in diameter from east to west and 5 miles from north to south. Some 8 miles to the northeast is the southwestern front of the San Juan Mountains, and about 16 miles to the south rise the northern slopes of the La Plata Mountains. The peaks are nearly all included within the northeastern section of the Rico quadrangle, but a few lie to the east of the one hundred and eighth meridian, in the Engineer Mountain quadrangle.

The name "Rico Mountains" was first applied to this group of peaks in the course of the work leading to the present report. On the Hayden map of Colorado the term "Bear River Mountains" was used for the same group, but that name has never come into local use, and would now be a misnomer, for it is connected with a nomenclature for important streams which has also failed of acceptance in the settlement of the country since the issue of the Hayden map. On that map the stream now known as the "West Dolores" River was called "North Fork of Rio Dolores;" the main stream, now named the "Dolores River," was designated the "South Fork of Rio Dolores, or Bear River," and from the latter alternative name originated the term applied to the mountains in question. The tributary of the Dolores heading in the La Plata Mountains has long been known as Bear Creek. On the Hayden map it has the name "La Plata Fork."

While the Hayden name for this mountain group has been rejected in local usage the engineers and miners of the region have failed to supply a new one, but the individual character of the group, both geologically and physiographically, makes some name desirable, and that here adopted seems most appropriate. The mining town of Rico is situated in the Dolores Valley, in the heart of the group.

A detailed survey of the Rico Mountains has been made both on account of the economic importance of the district and as a necessity in connection with the areal geological mapping of the San Juan and adjacent mountains, now in progress. In the course of this work the Rico quadrangle was taken up in 1897 and finished, with the exception of the small area about Rico, where the geology was found to be so complicated as to require an accurate and detailed topographical base. It was also seen that an intelligent exploitation of the mineral resources of the district was practically impossible until such a geological map should be available.

In the summer of 1898 the topographical map was made, and on its completion the geological work was at once begun, but could not be finished before the snowfall of early winter. In the season of 1899 the work was completed. During the work of the three years mentioned Mr. Arthur C. Spencer was associated with the writer as assistant geologist. Messrs. Ernest Howe, R. D. George, and Jason Paige served at different times as volunteer aids.

In 1897 Mr. C. W. Purington, assistant geologist, examined the ore deposits of the district, but the determination to make a special map and report rendered it desirable to have a correspondingly detailed study of the economic resources in the following year, and to this duty Mr. George W. Tower, jr., was assigned, as Mr. Purington had meanwhile resigned from the Survey. Before preparing his report upon the Rico district Mr. Tower also left the Survey to engage in private business. As some of the most complicated portions of the region, including the Silver Creek Valley, were not thoroughly understood during Mr. Tower's work, a further study of the ore deposits in the light of the geology will be carried on by F. L. Ransome in the season of 1900.

CHAPTER I.

OUTLINE OF THE GEOLOGY.

By Whitman Cross.

LITERATURE CONCERNING THE REGION.

Hayden Geological Survey.—The country adjacent to Rico was visited by geologists of the Hayden Survey in 1874 and 1876. In the former year the late F. M. Endlich examined the district to the east, the one hundred and eighth meridian, passing through Telescope Mountain, being apparently the general western boundary of his field of work. In 1876 W. H. Holmes made a rapid reconnaissance over an enormous area of the plateau country to the west. The complicated geology of the Rico uplift, coming on the border zone between the fields of different men working in different seasons, did not receive adequate attention, and the Hayden map of this area is, therefore, quite unsatisfactory.

From his report for the year 1874 it would appear that Endlich visited Blackhawk Peak ("Station 37"), approaching it from the east, but that he did not examine any other part of the mountain group. Since no benefit can come to the present report from a critical review of Endlich's inaccurate observations and misconceptions regarding the local geology, they will be passed over with brief comment. He published two profile sections running through Blackhawk Peak, but the data of these profiles, of the published map in the Geological Atlas of Colorado, and his statements of observations do not agree, and they are all decidedly erroneous in most particulars. What Endlich saw of the Rico dome structure was interpreted as a rather sharp anticline running along Silver Creek. Some of the intrusive sheets about Blackhawk Peak were observed, but it is difficult to understand on what basis the porphyry sheet of Hermosa Peak was extended westward along the divide to the summit of Telescope Mountain. Endlich later became the superintendent of the first smelter at Rico, but he published nothing further concerning the geology of the region.

The Hayden map of the western part of the Rico Mountains is the work of W. H. Holmes, and the inconsistencies in stratigraphy about the head of the Dolores River are due to the necessary adjustment between his work and that of Endlich. Holmes established a section of the Mesozoic formations to the west, which was expressive, adequate to the needs of the reconnaissance map, and in its general features is to-day recognized as correct. Endlich, on the other hand, had established an inadequate and partially incorrect stratigraphic section for the same formations, and where these two systems of mapping came together there was naturally a forced representation of unconformities by overlap which did not exist. This explains the drawing of the Hayden map about the Rico Mountains. The porphyry masses of Elliott Mountain and Calico Peak were observed by Holmes from a distance and represented with some approximation to correctness.

John B. Farish.—In 1892 John B. Farish read a paper before the Colorado Scientific Society entitled On the Ore Deposits of Newman Hill, near Rico, Colorado.[1] The description of the ore deposits was preceded by some general remarks on the geology. The structure of the mountains was recognized by Farish as a domal uplift, and concerning it he says: "The elevation of the mountains was associated in its origin with the intrusion of a laccolitic mass of porphyritic diorite, which may be seen a short distance above the town. The amount of upheaval at the center of the uplift was several thousand feet. Its longer axis is at right angles to the course of the river, and is so coincident with the corresponding axis of the laccolite." It is not evident what outcrops were assumed to represent the large laccolith, but the sheet at the northern base of Newman Hill is referred to as an offshoot from it. The rock of the laccolith is said to be probably a "hornblende-augite-porphyrite (a porphyritic diorite)," on the authority of R. C. Hills. Faults were recognized by Farish, but probably only the minor ones of Newman Hill.

The sedimentary rocks about Rico are stated by Farish to be "Lower Carboniferous and Carboniferous proper," but the grounds for the determination are not given.

T. A. Rickard.—A detailed description of the Enterprise mine was published in 1896 by T. A. Rickard, then superintendent of the mine.[2] In this paper there are but few statements concerning the general geology. The strata about Rico are said to be fossiliferous and to belong to the Lower Carboniferous, and the common igneous rock is called porphyrite, with a concise description by R. C. Hills. Rickard refers to "a large dike of porphyrite" crossing the valley north of Rico, "making a fault which breaks the continuity of the country on either side." It would appear that this reference, as well as that of Farish, above noted, concerning the supposed laccolith, must be to the mass of schists with small dikes of hornblendic porphyry; but the position and importance of the fault are not further indicated.

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[1] Proc. Colorado Sci. Soc., Vol. IV, pp. 151-164.
[2] Trans. Am. Inst. Min. Eng., Vol. XXVI, pp. 906-980.

The papers of both Farish and Rickard deal mainly with the Enterprise mine and give many important details of the geology of Newman Hill, as thus revealed, to which reference will be made further on in describing this locality.

Telluride and La Plata folios.—The first results of the resurvey of the San Juan region, now in progress, are contained in the Telluride folio, No. 57 of the Geologic Atlas of the United States, issued in 1899. The southwestern corner of the Telluride quadrangle is situated almost at the northern base of the Rico Mountains, 4 miles north of Telescope Mountain. While the structure of the Rico Mountains extends into the Telluride quadrangle but a very short distance, the Mesozoic formations there exposed are the same seen at Rico, and the discussion of several of them is fuller in the folio than in the present report. But the most important bearing of Telluride geology upon that of the Rico Mountains is in connection with the intrusive monzonite porphyries, the stocks of granular rocks, and the surface volcanic series of the San Juan. The age of the Rico dome, the conditions at Rico at the period of its elevation, and other problems of local geology must be discussed in the light of the facts observed in the Telluride quadrangle.

The La Plata Mountains, situated mainly in the quadrangle of the same name and lying directly south of Rico some 16 to 25 miles, are so analagous to the Rico Mountains in general character that their description in the folio now in press (Geologic Folio No. 60, La Plata) is in a measure supplementary to that of the Rico group. The domal structure is simpler because there are no profound faults, the intrusive porphyries are of the same general character as those of Rico, and there are several stocks of granular rocks, monzonite, diorite, and syenite, cutting the porphyry sheets.

GENERAL DESCRIPTION OF THE MOUNTAINS.

Physiographic relations of the mountain group.—The Rico Mountains form a small, compact group of peaks resulting from the deep dissection of a local dome-like uplift of sedimentary and intrusive igneous rocks. This uplift appears on the eastern border of the Dolores Plateau, which is continuous westward with the Great Sage Plain of Utah, extending to the brink of the Colorado Canyon. The termination of the Dolores Plateau on the line passing through the Rico and La Plata mountains is due to a change in the attitude of the underlying sedimentary formations. Beneath the plateau they are approximately horizontal, but on the line mentioned they come under the influence of the monoclinal folding which has taken place in a broad zone adjacent to the San Juan Mountains.

The relations of the Rico Mountains to the Dolores Plateau are well illustrated by the topographic map of the Rico quadrangle. On that sheet the plateau surface is shown crossing the western boundary with a general elevation of about 9,400 feet, rising very gradually for several miles and then merging into a gently dipping surface on the borders of the Rico uplift, a short distance beyond the limits of the special map. To the east of the Rico Mountains the countr[illegible] undulating character, modified by a few prominen[illegible] igneous rocks. Pl. I exhibits the character of the zone [illegible] the Rico and San Juan Mountains as seen from near the summit of Blackhawk Peak, the highest of the Rico group. At a distance of 8 or 10 miles rise the very rugged peaks of the San Juan. In the middle ground, on the right, is Hermosa Peak, caused by an intruded porphyry mass which is probably continuous with the white cliffs of Flat Top, seen on the left hand of the view. The low mountain with a light-colored band on its southern face, about 2 miles from Blackhawk Peak, presents a beautiful section of the white La Plata sandstone, dipping gently away from the point of view under the influence of the Rico uplift.

Another view of this belt of country east of the Rico Mountains is presented in Pl. II, a photograph taken from the knoll (11,886 feet) on the divide northeast of Telescope Mountain, looking east toward Hermosa Mountain. In Pl. XIX (p. 148) is shown the character of the country between the Rico and La Plata mountains. The crest line of the central portion of the view is Indian Trail Ridge, the divide connecting the two mountain groups, which is made up of red Triassic strata dipping at a low angle southwest and passing under the Jurassic and Cretaceous beds on the right-hand border of the view.

Drainage system and vegetation.—The Rico Mountains are cut into two nearly equal parts by the Dolores River, which receives all the drainage from within the group and from its northern and southern slopes. On the western side a portion of the drainage is into the West Dolores River, and on the east heads one of the tributaries of the Animas River.

Timber line in the Rico Mountains lies between 11,500 and 12,000 feet, and its course may be traced in several of the illustrations accompanying the report. The trees and shrubs are those common in the mountains of Colorado, with perhaps greater variety than usual in the lower sheltered valleys.

Details of physiography.—A glance at the accompanying map (Pl. XXII, in pocket) shows that the Rico Mountains consist of a circle of high and rugged peaks, divided into two crescent-shaped halves by the Dolores Valley. There are twelve peaks, each exceeding 12,000 feet in elevation above sea level, and the narrow crest connecting them rarely sinks below 11,500 feet on either side of the river. In passing

RECENT GEOLOGIC HISTORY.

Many of the features of post-Glacial geology at Rico are inseparable in origin from similar features of Glacial and earlier time, since in those parts of the area that were not covered by the ice similar processes of general erosion and of local deposition were active throughout the Glacial stage. For this reason, in classing the following phenomena as recent, there is no intention of limiting their age to the post-Glacial, but rather to indicate that the conditions which have produced them have continued down to the present time. The recent phenomena of the Rico region may be classed as those of erosion and those of deposition. The latter will include landslides, talus and avalanche materials, river gravels, and spring deposits.

Post-Glacial erosion.—If the gravels observed by Mr. Cross at an elevation of 700 feet above the river on the northern edge of the monzonite are really of glacial origin, they indicate a much greater accumulation of such débris in the Dolores Valley than would be suggested by any other occurrences. But even if they are glacial, the work of the river seems to have been largely the removal of the gravels, with little cutting into the underlying rock. In Deadwood and Allyn gulches the streams have cut down through the unconsolidated gravels of glacial origin, but this is a task which they could have easily accomplished in a short time. Similar indications of the small effect of post-Glacial bed-rock erosion are seen in Silver Creek, where the stream has locally excavated narrow canyons in the wider valley of glacial origin, but these canyons have in no instance exposed the bed rock to a depth of more than possibly 20 feet, and in many places the stream is working upon débris of very recent origin, which has been thrown into its channel from the side gulches and ravines. All the evidence serves to point to the recency of the glacial occupation and to the small amount of erosion which has since ensued. The present topography is in no essential feature different from what it was previous to the accumulation of the ice. Before that the streams had found their present courses and had practically assumed their present grades. Greatly in excess of any topographic changes due to erosion are those attributable to the constructional features which are discussed in the following paragraphs.

Varieties of surface deposits.—The surface deposits at Rico are of very diverse character and origin, and, as has been seen in the discussion of the glacial gravels, they are not easily separable as to origin. They are very troublesome to the geologist, since they cover the central part of the region to such an extent that it has been found impossible to work out the geology of the solid rocks underlying. Consequently it is necessary to represent them on the map, and for this purpose five distinct patterns have been used to distinguish (1) areas made up principally of landslide material; (2) valley gravels; (3) alluvial cones; (4) spring deposits; (5) materials of other origin, such as avalanche, glacial, and surface wash.

Landslides.—The most important surface deposits in the Rico Mountain are of landslide origin. One such slide has materially altered the grade of the Dolores River north of Rico, others have changed the profile of Horse Gulch, while still others lend their characteristic pseudo-glacial topography to the mountain slopes in several places. This feature of the Rico region has been specially studied by Mr. Cross, and its description and discussion are given a separate chapter in this report.

Talus.—Accumulations from the wasting of cliffs are related in origin to landslides, but are composed of many small blocks loosened by frost action or by heavy rains, whereas landslides, though they may eventually become very much broken, are at first essentially large masses. Talus forms are of frequent occurrence at Rico, and while in many cases, especially in the lower parts of the mountains, their even slopes are covered with vegetation, in other cases they are entirely bare and then suggest the manner in which they were formed, namely, by the rolling and sliding of loose rock fragments under the action of gravity. They are well illustrated in several of the accompanying plates, particularly in Pl. VI (p. 28), showing the steep talus at the base of the Sandstone Mountain cliffs, and in the view of Calico Peak (Pl. VII, p. 32) and that of Blackhawk and Dolores peaks from the north (Pl. IV, p. 24). The long talus streams upon the west slope of Nigger Baby Hill are largely derived from the mines which are situated at their heads, but the whole adjacent slope is covered by natural talus or wash through which very few outcrops appear.

Related to talus are the materials dislodged by avalanches and deposited where their force is spent. Much of the loose material upon Newman and C. H. C. hills has been brought down in this way, and the paths which have been cut through the timber upon the western slope of Dolores Mountain may be made out from the photograph of this slope (Pl. III, p. 22). Other ravines than these, which have been the tracks of snowslides, may be seen at various places. Some of the best marked are on the south side of Burnett Creek, upon the flank of Landslip Mountain.

The deposits of Papoose Gulch and in the head of Marguerite Draw west of Mount Elliott have been mentioned in discussing the glacial phenomena, where they are considered as connected with former great snow banks. Probably this is, in part at least, their true origin, but avalanches may have been also concerned in their formation.

Surface wash.—In regions where the agents of erosion have been as active as at Rico rocks do not decay in situ by surface weathering, and consequently residual soils, such as cover the rocks in many low-lying regions, do not accumulate. Surface wash is composed almost entirely of fragments derived from the higher slopes of the mountains, or from the disintegration of landslides which, gradually moving toward the valleys under such effective aids to gravity as snow, rain, and frost, have been spread in varying thickness over extensive slopes, hiding the underlying formations as completely as have the more massive surface deposits. As may be inferred from such an origin, the materials of the surface wash are as a rule more completely pulverized than the other forms of surface deposits.

As in the case of all the surface deposits, the representation of surface wash on the map is generalized and the indicated boundaries are to be taken as approximate. The symbol under which they are included is intended to apply to all areas not referable to the three classes of landslides, valley deposits, and alluvial fans. It thus comprises the materials of mixed origin covering Newman Hill and the opposite slope west of the river.

Valley deposits.—The valley deposits of the Rico region comprise the gravels of the present flood plain of the river. They consequently occur in a band across the area and bordering the river, but interrupted above Horse Gulch by the great landslide at the base of C. H. C. Hill. This mass of rock which has been projected into the valley has pushed the stream against the western bank of the canyon, where it is now cutting in the solid rocks of the lower Hermosa. As may be seen by referring to the topographic map, it has interfered with the natural grade of the river, which is now abnormally steep adjacent to the slide block upon the lower side and as notably low in the reach upstream from it. The landslide at first formed a dam across the river, causing slack water for perhaps a mile and a half upstream. From the even spacing of the contours below the dam it is believed that the original stream bed at the lower end of the Burns meadow is approximately 75 feet below the present position of the river, the same figure representing the thickness of the materials deposited by the river at this place. If the same spacing which is noted below the landslide were continued upstream the 9,050-foot contour would have approximately its present position, so that it may be taken to represent about the upper limit of the effect of the landslide in changing the stream grade. From the dam to the present crossing of this contour the distance is slightly in excess of 1 mile, and the fall of the stream is not more than 25 feet, or less than one-fourth the normal fall for this distance. The northern edge of the landslide block and the flat above it are shown in Pl. XVI (p. 142).

The materials of the valley deposits are coarse gravels and sands which the river has derived from its tributaries and which it has rolled along and distributed within its immediate valley.

Alluvial fans.—The steeper gulches which open directly into the

Dolores Valley have all afforded detritus faster than the river has been able to carry it off, so that the débris brought down by the side streams has accumulated in conical banks at the mouths of the gulches. Such accumulations are commonly known as alluvial fans. They are a characteristic feature of the union of streams of steep grade with those of low declivity, since the transporting power of the steeper streams is suddenly diminished when their grade is reduced. The side streams at Rico do not at ordinary times carry any appreciable load of gravel, transportation being confined to times of flood. Heavy showers and cloud-bursts sweep débris into the steep gullies, and this, carried down to the main valley, is dropped, and the channel of the stream becomes inclosed by natural dikes, so that on becoming choked at any time the torrent will take a new course and, changing from time to time, will finally have swept through an arc limited by the valley walls and varying in width from 90 to 120 degrees. It is by thus changing its channel that the stream is able to build up the conical heap at its mouth.

At Rico many of the characteristics of alluvial fans are beautifully illustrated. An inspection of the map will show the extent of the principal ones and the different relative positions of the stream channels upon the cones, and in several cases the contouring indicates the lines of former channels. The typical appearance of the alluvial fans is shown in Pl. XXI, from a photograph of the Aztec fan taken at a point upon the east side of the river near the wagon road. In this case the present channel is central. Other abandoned courses may be made out in the aspens on the north side, and another exists along the southern edge but can not be seen in the illustration. An interesting feature also shown in this photograph is the smaller fan which has been formed in front of the larger one. From the relations exhibited it appears that the great fan originally extended farther to the east than at present, but that the river in shifting its course was thrown against its base and cut away its lower portion, producing the steep bank now exhibited. During this period of cutting the channel on the fan probably had a location different from the present. Since the channel was located at the position which it now has a secondary fan has been formed by material, a portion of which seems, from the depth of the channel, to have been derived from the upper part of the main fan.

Other fans than those represented occur in Silver Creek at the mouth of Allyn Gulch and of the next gulch above upon the south side. Also a portion of the surface materials upon the hillside west of Rico may have been formed in the same manner as the fans of the lower valley, which they very closely resemble as topographic features. These have not been distinguished from the adjacent surface débris.

Calcareous spring deposits.—The Rico Mountains are well watered, and even in the driest seasons most of the gulches contain very considerable streams which are fed by springs. The water of the springs is usually impregnated either with lime or with iron, probably of rather superficial origin, and locally these ingredients are frequently present in sufficient amounts to separate from solution and form deposits upon the surface or in the interstices of gravel or other loose surface materials. In some cases the waters, besides their mineral contents, are impregnated or accompanied by gases, such as sulphureted hydrogen and carbonic acid gas.

The generally calcareous nature of the spring water at Rico is a direct result of the richness of the prevailing sedimentary formations of the central region in carbonate of lime, but in most cases the amount of the mineral held in solution is not sufficient to give rise to important deposits of tufa. There are, however, several such deposits which are situated upon the lower slopes in localities where loose materials cover the solid rock for some distance above the springs. From this relation it seems likely that the waters travel underneath the surface of the ground from the higher elevations and, percolating through the loose surface materials, dissolve en route carbonate of lime, which they redeposit upon emerging at the surface, partly by evaporation and loss of carbonic acid and partly through the agency of the animals and plants which inhabit the boggy places about the springs. The lime is frequently deposited in such a way that ponds are formed, and in these small snails find a congenial habitat, the shells of successive generations gradually adding to the growth of the lime deposit. Moss growing in the bogs is continually saturated in the calcareous water, and becomes at first coated but finally entirely impregnated with the lime, giving rise to a spongy mass which is often found near the lime springs. Grasses, leaves, and twigs falling where the water can trickle over them are quickly entombed, and upon decaying leave their characteristic forms impressed upon the resulting rock. Leaf impressions may be found at almost any of the springs; they are especially well shown in the deposits above the wagon road south of Horse Gulch.

The principal deposits of calcareous tufa have been outlined on the map, by reference to which their extent and distribution may be seen.

At one locality the tufa has been quarried for a kiln and has found a considerable use, since it is conveniently located and produces lime of good quality.

Ferruginous deposits.—Iron-bearing springs occur at several places in the Rico Mountains, and have left local deposits of iron oxide, cementing surface débris and forming what is commonly known as "iron cap." Though occurring at other places, these ferruginous conglomerates are especially in evidence in Silver Creek above the Fort Wayne tunnel, in the upper part of the northern and western branches of Horse Gulch, and in the lower part of Horse Gulch at the base of the northern landslide area. Their origin is probably connected with the oxidation of iron pyrites, but their occurrence can never be safely taken as a clue to the proximity of large bodies of that mineral.

Gas springs.—Emanations of carbonic acid gas and of sulphureted hydrogen accompany many springs of water in the Rico region. The former is continually escaping in large quantities in the central part of the dome, while the latter is noted in many places on the west side of the mountain group in the drainage of Stoner and Bull creeks. Both gases doubtless have their origin in chemical changes which are going on at a greater or lesser depth beneath the surface, and the waters with which they are associated may or may not be of deep-seated origin. In some places they certainly are not, for in the case of the sulphur springs the water increases and diminishes with the humidity or dryness of the season, and at certain times the flow of water ceases entirely, but the gas continues to escape. It appears that in such instances the gases have found the same channels along which the waters are circulating and that the two mix and escape together. In like manner it is notable that the carbonic acid gas, which is escaping in large quantities in various places, is far in excess of the amount which can be absorbed by the water with which it issues, and in mine workings the gas is frequently encountered where it flows up from crevices without any water at all. In one of the borings of the Atlantic Cable Company, made several years ago, a flow of gas was tapped which, being confined, is said to have had a pressure of more than 50 pounds and to have maintained it, with slight decrease, to the present time. A similar pressure is reported to have been shown by gas encountered in a bore hole in the Rico-Aspen workings.

Several tunnels in the west bank of the Dolores at Rico have struck carbonic acid gas escaping from many fissures in the highly shattered rocks in the vicinity, and a spring of water strongly charged with this gas bubbles up through the gravels of the river bed not far from the Shamrock tunnel.

Several of the carbonic springs at Rico are locally known as "soda springs," and, while no analyses have been made of their waters, there is no reason for doubting the correctness of this designation. Their waters are highly charged with gas, an excess of which escapes in the form of bubbles, and are cool and of a delicious flavor, resembling, in this respect, the waters of known soda springs at other localities in Colorado.

COLORADO GEOLOGICAL SURVEY

DEPARTMENT OF NATURAL RESOURCES

STATE OF COLORADO

RECONNAISSANCE ENGINEERING GEOLOGY REPORT FOR PLANNING DISTRICT 9 STATE OF COLORADO

PREPARED FOR

THE COLORADO GEOLOGICAL SURVEY

AND

THE COLORADO DIVISION OF PLANNING

This document was financed, in part, through an urban planning grant from the Department of Housing and Urban Development under the provision of Section 701 of the Housing Act of 1954, as amended.

ENVIRONMENTAL GEOLOGY NO. 4

PRICE $1.00

SUMMARY

There is a possibility that natural resources may be discovered or further developed in any of the geologic units delineated by the principal map. Therefore, consideration must be given to the diverse future needs in areas of high development potential. The following examples point up the multiple use potential for some of the map units.

1. Alluvial deposits are a primary source for construction materials, such as sand and gravel, and are commonly found in stream valleys which are suitable for agricultural and residential development. Abandoned quarries can be developed into recreation sites.

2. Sedimentary rocks are host for fuel and energy resources (uranium, coal, gas and oil), and these rocks underlie many existing large communities in the Planning District.

3. Igneous, metamorphic and volcanic rocks locally yield significant amounts of metallic minerals. These areas are also attractive to recreational community developers.

Massive land movements or other unstable surface conditions are found most commonly in areas having moderate to extreme topographic relief and abundant moisture. However, this generalization is too restrictive for Planning District 9. The Mancos and Lewis shales are potentially troublesome even in areas of low topographic relief. These clay-rich rocks are seen to creep or move slowly down gentle slopes where they are poorly drained and/or altered by construction. The potential for unstable surface conditions must be evaluated carefully for every proposed development site.

The need for soil investigations at all construction project sites is seen dramatically throughout the District. Many public and private buildings have structural damage which has been caused, at least in part, by swelling or settling soils. The life of any structure can be prolonged significantly by proper foundation design based on good soil engineering data.

General areas of flood danger or erosional hazards are found in association with all drainage basins located within Planning District 9. The history of flooding within the District may fail to properly emphasize the importance of this observation. However, as the population density increases, so will the number of structures situated on flood plains. Planning efforts must take this fact into consideration and regulate development on flood plains to prevent future tragedies and economic loss.

Areas of high water table, both permanent and seasonal, are found throughout the District. This troublesome feature is related directly to geology and precipitation. Little control is available for regulating precipitation, but geologic investigations will delineate areas where rock materials have poor permeability and can point up corrective measures which will enable developers to make safe use of such land.

The text of the report clearly points up the fact that not all rocks nor physical settings are suitable for solid waste disposal sites. Geologic evaluations must be made to determine whether the rock material in question is workable and will provide an effective seal, and whether there is any danger of pollution to a community water supply. With these guidelines, planners can be aware of special studies needed to meet public health standards.

There is a distinct possibility that mine dumps found throughout the District may be contributing to environmental pollution or presenting hazards to the unwary developer. The intensity of the problem will be related to the type of mine (such as the subsidence or the water contamination potential associated with coal mines) and the proximity of the mine to streams or water bearing rock units. Thorough investigations and reclamation projects may have to precede development work in some of the intensively mined areas within the District.

Many critical geologic factors affecting planning and development are explained in the text of the report. This information provides guidelines to those responsible for protecting public interests within the District. Application of this data will help to ensure safe, efficient and environmentally sound land use decisions. In summary, the need is stressed for site-oriented geologic and engineering investigations to evaluate problems and provide solutions for specific land use proposals.

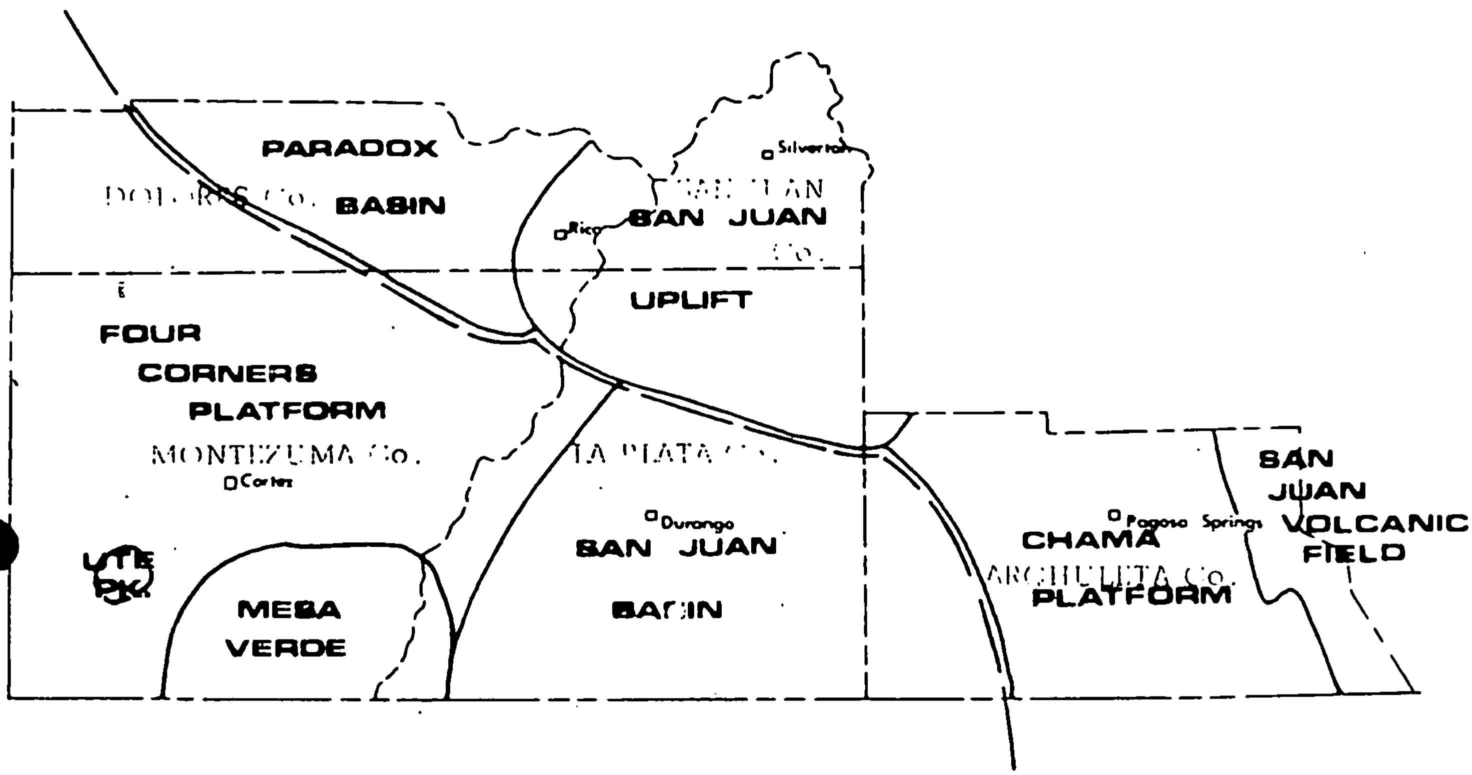
PHYSIOGRAPHIC FEATURES

The five county area which comprises Planning District 9 is situated in the southwest corner of Colorado. The Continental Divide is located near the northeast side of the District - lying within parts of the eastern sides of Archuleta and San Juan Counties. Elevations are seen to range (southwest to northeast) from 4,900 to 14,250 feet above sea level. The mean elevation is approximately 7,500 feet. The region can be described as mountainous, although the western and southern areas are part of the large physiographic province called the Colorado Plateau (Figure 3). The plateau region is dissected by drainage patterns which provide topographic continuity to the rugged nature of the alpine region. Principal rivers flow in south-southwest directions across the region with the exception of a part of the Dolores River which flows northwest through the northwest corner of the District.

GENERAL GEOLOGY

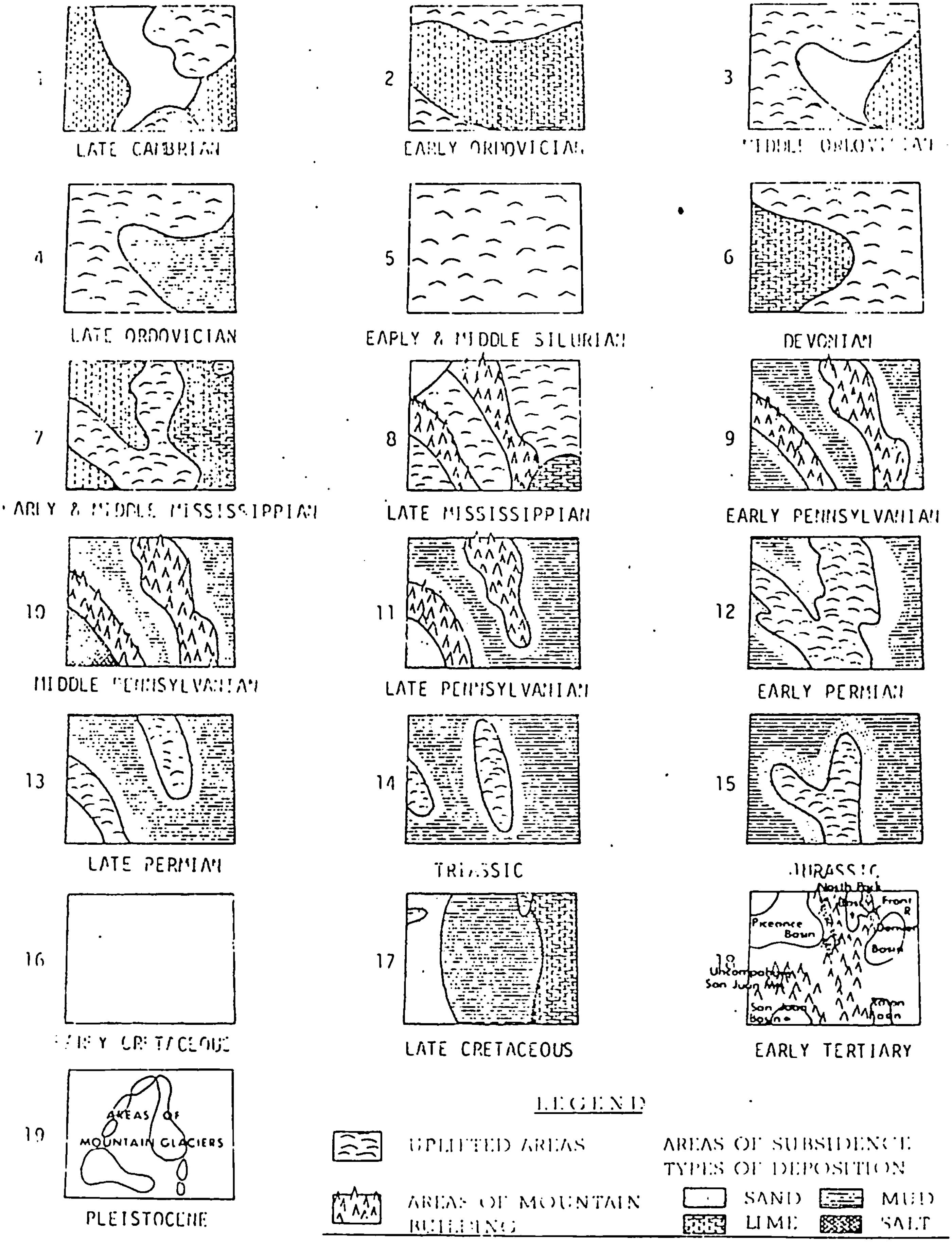
Figure 4 illustrates the geologic evolution of the State of Colorado and lists the geologic events for Planning District 9 in the order of occurrence. This synopsis shows the development of the various geologic units which eventually formed the present features of the area. A numerical cross reference is provided for the two parts of Figure 4 so that comparisons can be made between local and regional geologic events.

The geologic history of the Earth goes back approximately four billion years when the Earth was probably nothing more than a molten mass. The geologic history of interest to this report began about two and one-half billion years ago during the Late Precambrian Era as masses of various types of sedimentary and igneous rocks were repeatedly formed, buried, altered, uplifted and injected with new igneous bodies. About 600 million years ago, the first well-defined geologic periods began. The first was the Cambrian Period during which sand and lime accumulated in the sea which covered the District. Approximately one hundred million years later, the



MAJOR PHYSIOGRAPHIC FEATURES OF PLANNING DISTRICT 9

Figure 3



GEOLOGIC EVOLUTION OF THE STATE OF COLORADO

GEOLOGIC EVENTS IN PLANNING DIST. 9

ERA	PERIOD
CENOZOIC	QUATERNARY
	TERTIARY
MESOZOIC	CRETACEOUS
	JURASSIC
	TRIASSIC
PALEOZOIC	PERMIAN
	PENNSYLVANIAN
	MISSISSIPPIAN
	DEVONIAN
	SILURIAN
	ORDOVICIAN
	CAMBRIAN

MILLIONS OF YEARS: 0, 1, 50, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600

19 Glaciers cover the San Juan Mts. and carve present landforms.

18 Extensive volcanism: Silverton Caldera formed.

17 ROCKY MOUNTAINS UPLIFTED: San Juan Basin subsides.

Lime and mud deposited in eastern Colorado as seas deepen: Sand deposited in western Colorado from landmasses in Utah.

16 Sands deposited in shallow seas covering the entire state.

15 Mud and sand deposited from a low landmass in central Colorado.

14 Mud and sand deposited from mountain remnants in central and west central Colorado.

13 Frequent uplift and subsidence of land, advance and retreat of seas.
Sand and mud deposited in the shallow seas covering the Paradox Basin as the mountains erode and subside.

12

11 Salt deposited in the Paradox Basin.
Mountains uplifted in the central and southwest portion of the state; Paradox Basin subsides.

8 A low landmass emerges in the northeast portion of the District.

6 Lime deposited in seas covering the District.

Landmass subsides to become a shallow sea.

5

4

District is uplifted to form a low landmass.

1

District is covered by shallow seas; lime is deposited.

All of earth history to the Cambrian occurs in the Precambrian, little of which is preserved in the rock record.

Figure 4

Ordovician Period began with the gradual uplift of the region effecting the withdrawal of the sea and terminating the deposition of sediments. The region remained positive (a land area) throughout the Silurian Period. Slightly more than 400 million years ago (Devonian Period), the area was submerged and lime sediments accumulated in the shallow sea. Later, during the Mississippian Period, a broad region was uplifted to form mountain ranges in approximately the same location as the present Rocky Mountains. During the Pennsylvanian and early Permian Periods, the southwestern part of the District was subjected to alternating times of emergence and submergence. Shallow marine sediments consisting of sand, clay and salt accumulated in the region. Between 250 and 130 million years ago, Late Permian to Early Cretaceous time, the pattern of alternating uplift and subsidence of the land continued. Sediments forming in these seas included sand and clay, but not evaporites such as salt and gypsum. Shallow seas covered the entire State during the Cretaceous Period, and most of the sedimentary rocks that are found in the area today were deposited during that time. About 70 million years ago, the Tertiary Period began with extensive volcanism and mountain building movements. During that period, the San Juan Mountains were formed and the San Juan Basin subsided to form a small sea. This sea was probably an inland sea much as the Great Salt Lake is now. It was during this time that the Rocky Mountains were uplifted to their present position. Approximately 1 million years ago, during the Quaternary Period, much of the area was covered by mountain glaciers which carved the present land forms. In Recent Time, erosion of these land forms has produced the topographic relief seen today.

HOW TO USE THIS REPORT

This report has been prepared specifically for Planners and other Public Officials who share the broad responsibilities for making safe, effective and environmentally sound land use decisions. It has been assumed that those reading

ATTACHMENT III

CERCLA ELIGIBILITY WORKSHEET

PA Guidance
EPA Region VIII
August 1993

CERCLA Eligibility Worksheet

Site Name Rico - Argentine

City Rico State Colorado

EPA ID Number COD980952519

Note: The site is automatically CERCLA eligible if it is a Federally owned or operated RCRA site.

I. CERCLA Eligibility

Did the facility cease operations prior to November 19, 1980? No

If YES, then STOP. The facility is probably a CERCLA site.
If NO, continue to part II ____

II. RCRA Deferral Factors

Did the facility file a RCRA Part A application? No

If YES:

1. Does the facility currently have interim status? ____
2. Did the facility withdraw its Part A application? ____
3. Is the facility a known or possible protective filer? (filed in error) ____
4. Does the facility have a RCRA operating or post closure permit? ____
5. Is the facility a late (after 11/19/80) or non-filer that has been identified by the EPA or the State? (facility did not know it needed to file under RCRA) ____

Type of facility:

Generator____ Transporter_____ Recycler ____
TSD (Treatment/Storage/Disposal) _____

If all answers to questions 1, 2, and 3 are NO, STOP. The facility is a CERCLA eligible site.

If answer to #2 or #3 is YES, STOP. The facility is a CERCLA eligible site.

If answer to #2 and #3 are NO and any other answer is YES, site is RCRA, continue to part III.

III. RCRA Sites Eligible for the NPL

Has the facility owner filed for bankruptcy under Federal or State laws? No

Has the facility lost RCRA authorization to operate or shown probable unwillingness to carry out corrective action? No

Is the facility a TSD that converted to a generator, transporter or recycler facility after November 19, 1980? No

IV. Exempted substances:

Does the release involve hazardous substances other than petroleum? Yes

V. Other programs: The site may never reach the NPL or be a candidate for removal. We need to be able to refer it to any other programs in EPA or state agencies which may have jurisdiction, and thus be able to effect a cleanup. Responses should summarize available information pertaining to the question. Include information in existing files in these programs as part of the PA. Answer all that apply.

Is there an owner or operator?

Yes. Rico Development Corp.

NPDES-CWA: Is there a discharge water containing pollutants with surface water through a point source (pipe, ditch, channel, conduit, etc.)?

Acid-mine water discharge

CWA (404): Have fill or dredged material been deposited in a wetland or on the banks of a stream? Is there evidence of heavy equipment operating in ponds, streams or wetlands?

Settling ponds on banks of Dolores River, Silver Creek

UIC-SDWA: Are fluids being disposed of to the subsurface through a well, cesspool, septic system, pit, etc.?

TSCA: Is it suspected that there are PCB's on the site which came from a source with greater than 50 ppm PCB's such as oil from electrical transformers or capacitors?

FIFRA: Is there a suspected release of pesticides from a pesticide storage site? Are there pesticide containers on site?

RCRA (D): Is there an owner or operator who is obligated to manage solid waste storage or disposal units under State solid waste or ground water protection regulations?

UST: Is it suspected that there is a leaking underground storage tank containing a product which is a hazardous substance or petroleum?

COLORADO NATURAL HERITAGE PROGRAM
The University of Colorado Museum
Hunter 115, Campus Box 315
Boulder, Colorado 80309-0315
(303) 492-4719 • Fax (303) 492-5105

RECEIVED
APR 2 5 1994
URS/ARCS

The Nature Conservancy

April 13, 1994

Mike Carr
URS Consultants, Inc.
1099 18th Street, Suite 700
Denver, CO 80202

Dear Mr. Carr:

The Colorado Natural Heritage Program (CNHP) is in receipt of your recent request for information regarding the Brighton-Ft. Lupton Landfill and the Rico-Argentine Mine. In response, CNHP has searched it's Biological and Conservation Datasystem for natural heritage resources (occurrences of significant natural communities and rare, threatened or endangered plants and animals) documented from T1N R66W and T40N R11W.

According to the information currently in our files, there are no occurrences of significant natural communities or rare, threatened or endangered species documented from within the four-mile radius of the Brighton-Ft. Lupton Landfill site. However, there is one occurrence of Eustoma russellianum (also known as Eustoma grandiflora, Showy prairie gentian, approximately 15 miles downstream, west of the South Platte River in the vicinity of Lyons Road, north of Colorado Hwy 66 and west of Road 23. This species is ranked very common globally, but is considered rare to uncommon in Colorado and is under review for federal listing. A 1989 report indicated that habitat for this species has been intensively grazed and/or cultivated over the past 100 years: causing concern that this species could be disappearing (Jennings, 1989).

A review of the Rico-Argentine Mine project area indicated an occurrence of one significant natural community within the four-mile radius of the site, as well as two additional occurrences of significant natural communities within the 15-mile downstream limit. Populus angustifolia-Picea pungens/Alnus incana, a montane riparian forest, can be found along the east bank of the Dolores River within four miles of this project area. An occurrence of an Abies lasiocarpa/Alnus incana/Salix drummondiana montane riparian forest has been documented 1.5 miles up Priest Creek trail from the Dolores River. Both of these communities are ranked rare to uncommon both globally and in Colorado. Also, a 1991 field survey reported that threats to the community A. lasiocarpa/A. incana/S. drummondiana include erosion, flooding, and grazing (Kittel & Lederer). A Populus angustifolia/Cornus sericea montane riparian forest occurs along the Dolores River approximately 15 miles downstream. This natural community is ranked very rare globally and in Colorado. Alteration of the hydrologic regime may adversely affect these natural communities.

aspen tree

cactus

outside 4-mile

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URS Project No. 41881
Log No. 41,70,B1024
☐ Original ☐ Copy

While the information contained herein represents a thorough search of the CNHP's Biological and Conservation Datasystem, any absence of data does not necessarily mean that other natural heritage resources do not occur on or adjacent to the project site, but rather that our files do not currently contain information to document their presence. CNHP's datasystem is constantly growing and revised. Please contact CNHP for an update on this natural heritage information if a significant amount of time passes before it is utilized.

Sincerely,

Katie Pague

Katherine E. Pague
Information Manager

STATE OF COLORADO
Roy Romer, Governor
DEPARTMENT OF NATURAL RESOURCES

DIVISION OF WILDLIFE

AN EQUAL OPPORTUNITY EMPLOYER

Perry D. Olson, Director
6060 Broadway
Denver, Colorado 80216
Telephone: (303) 297-1192

151 E. 16th St.
Durango, CO 81301
303-247-0855

REFER TO

For Wildlife–
For People

June 6, 1994

Mark Carr
URS Consultants
1099 18th St., Suite 700
Denver, CO 80202

Dear Mr. Carr,

This letter is in reference to your request for State sensitive wildlife species in the Rico, Colorado area. I have conferred with Rich Lopez, District Wildlife Manager (CDOW), who works the Rico area. To our knowledge there are no threatened or endangered species resident in the Rico vicinity. The Boreal toad *(Bufo boreas)* may inhabit wetland stream or pond areas, but there have not been any studies conducted to verify their presence or absence.

The Dolores River above Rico experiences heavy fishing pressure. The Division of Wildlife stocks fish in the river through the town of Rico. The upper head waters of the Dolores support a viable native cutthroat trout fishery. Silver creek has virtually little aquatic life because of the heavily mineralized water below the mines (first two miles). The Division has stocked native cutthroat trout approximately 2 miles above the town in Silver creek and they are doing relatively well.

The Dolores River was one of the target drainages to re-introduce the River otter, a State endangered species, but to our knowledge they are not present this far up the Dolores River drainage.

If I can help you further with your project please feel free to ask.

Sincerely,
Ruth Lewis Carlson

Ruth Lewis Carlson
Habitat Biologist

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Log No. 41 ,70 ,B1022
☐ Original ☐ Copy

cc: Clark, Zgainer, Lopez

United States Department of the Interior

TAKE PRIDE IN AMERICA

BUREAU OF RECLAMATION
DENVER OFFICE
P.O. Box 25007
Building 67, Denver Federal Center
Denver, Colorado 80225-0007

IN REPLY REFER TO
D-5724
RES-3.20

May 25, 1994

Mr. Mike Carr
URS
1099 18th Street, Suite 700
Denver CO 80202

Subject: Water Quality and Sediment Data on the Dolores River

Dear Mr. Carr:

As per your request, I am enclosing the water quality and sediment data that Reclamation's Durango Office collected on the Dolores River. The samples span the period from 1989 through 1993. The data files are on the enclosed diskette in LOTUS® version 3.1 format. The water quality data are included in the file WTR-QUAL.WK3. The water quality data were analyzed at several different laboratories, which are identified in the data files. The sediment data are in the file named SEDIMENT.WK3. The sediment analyses were performed by the Geological Survey Geochemistry Branch Laboratory here in Denver.

As we discussed on the telephone, I am enclosing a copy of the preliminary draft of a report on the analysis of the Dolores data that I have been preparing. The report deals with the data collected through 1992. The additional water quality and sediment samples collected during 1993 were a result of the report. It should be noted that the enclosed report has undergone absolutely no review. I stopped work when it became apparent that the initial hypothesis on which the study was designed, *i.e.*, that the source of mercury in fish in McPhee Reservoir was in the Rico Mining District, was not supportable based on the data. There were several alternative hypotheses that could be investigated. One of these concerned air-borne mercury from powerplants to the southwest. An investigation conducted by the EPA's Environmental Monitoring and Support Laboratory in Las Vegas during 1977 indicated that the vast majority of the mercury emitted by the Four Corners Power Plant moved off site. A copy of the summary sheet from that report is also enclosed for your information. Another possibility was that the source of the mercury was a tributary nearer the reservoir. The 1993 samples focus on the lower reaches of the river. This aspect of the problem is not addressed in the report.

The enclosed report is very preliminary. It contains no discussion or conclusions. Any conclusions drawn from what is presented in the report will have to be your own. I will respond to any questions that might arise in relation to the material in the report. I can be reached at 303/236-3778.

Sincerely,

Jim Yahnke

Jim Yahnke
Hydrologist

EPA CLOSEOUT COPY

Enclosures

URS
Project No. 41881
Log No. 41,70,B1021
☐ Original ☐ Copy

DOLORES RIVER WATER QUALITY IMPROVEMENT STUDY
Sample Station Locations

REVISED May 23, 1994

SURFACE WATER STATIONS:

STATION	LATITUDE	LONGITUDE	DESCRIPTION
DRDOL01T	37-46-27.5 N	107-58-47.5 W	Barlow CK. near mouth at the bridge
DRDOL02T	37-46-37.5 N	107-58-43.75 W	Dolores River just above confluence with Barlow Ck.
DRDOL03T	37-43-31.25 N	108-01-48.75 W	Dolores River at Peterson Slide
DRDOL04T	37-45-30.0 N	108-07-38.75 W	Geyser Ck. near the mouth
DRDOL05T	37-47-18.75 N	108-05-10.0 W	West Dolores River approx.1/8 mile above Cold Ck.
DRDOL06T	37-40-02.5 N	108-02-12.5 W	Dolores River at Rico City Park
DRDOL07T	37-39-38.7 N	108-02-37.5 W	Scotch Ck. near the mouth just above the bridge
DRDOL08T	37-38-37.5 N	108-03-26.25 W	Dolores River at the Montelores Bridge
DRDOL09T	37-35-13.75 N	108-21-30.0 W	Dolores River approx. 1/8 mile above confluence with West Dolores River
DRDOL10T	37-42-01.25 N	108-01-42.5 W	Silver Ck. near the mouth at the bridge
DRDOL11T	37-43-25.0 N	108-01-50.0 W	Dolores River at the bridge above Rico
DRDOL12T	37-28-27.5 N	108-30-15.0 W	Dolores River at Dolores-USGS gauging station (sampled by Cortez)
DRDOL13T	37-37-16.0 N	108-03-42 W	Wildcat Creek near mouth
DRDOL14T	37-34-26.0 N	108-11-02 W	Bear Creek near mouth
DRDOL15T	37-30-59.0 N	108-22-47 W	Rock Spring Creek near mouth
DRDOL16T	37-39-28.0 N	108-18-37 W	Cottonwood Ck about 0.25 mi. above West Dolores Road bridge
DRDOL17T	37-34-14.0 N	108-38-01 W	Taylor Creek near mouth
DRDOL18T	37-35-08.0 N	108-09-19 W	Priest bulch near mouth
DRDOL19T	37-35-57.0 N	108-06-23 W	Roaring Forks Ck near mouth
DRDOL20T	37-35-24.0 N	108-18-55 W	Stoner Creek near mouth
DRDOL21T	37-34-43.5 N	108-14-02 W	Fish Creek near mouth
DRDOL22T	37-45-21.0 N	108-07-45 W	Geyser Ck Hot Spring near West Dolores River below Geyser Ck
DRDOL23T	37-46-47.0 N	108-05-14.5 W	Cold Creek near mouth
DRDOL24T	37-35-23.0 N	108-21-04.5 W	West Dolores River near mouth
DRDOL25T	37-28-06.0 N	108-30-26 W	Lost Canyon Creek near mouth
DRDOL26T	37-45-21 N	108-07-45 W	West Dolores River below Geyser Creek by Hot Spring.
DRDOL27T	37-43-42 N	108-15-39 W	Fish Creek below spring and 1/4 mi. below DRDOL21T.
DRDOL28T	37-40-00 N	108-02-07 W	SPring or old mine flow below Rico CO above Rico City Park.
DRDOL29T	37-43-31.25 N	108-01-48.75 W	Spring of flow out of old buried mine shaft by DRDOL03T.
DRDOL30T	37-30-20 N	108-23-20 W	Outflow from Wallace Reservoir at mouth prior to Dolores River.
DRDOL31T	37-45-46.25 N	108-59-26.25 W	Coal Creek 1.5 miles down from confluence of Barlow and Dolores River.
DRDOL32T	37-42-51.25 N	108-02-05 W	Horse Creek by ranger station north of Rico CO.
DRDOL33T	37-37-1.25 N	108-5-27.5 W	Tenderfoot Creek 1.5 miles below Wildcat Creek.
DRDOL34T	37-37-00 N	108-5-23.75 W	Tenderfoot Creek below pond 1.5 miles below Wildcat Creek.
DRDOL35T	37-34-31.25 N	108-17-30.06 W	Loading Pen Creek half-way between Taylor and Stoner Creeks.
DRDOL36T	37-35-37 N	108-08-7.5 W	Section House Creek 1 mile east if Priest Creek.
DRDOL37T	37-35-47.5 N	108-07-45 W	School House Creek about 1.5 miles east of Priest Creek at DRDOL18T.
DRDOL38T	37-35-33.75 N	108-07-53.75 W	Rio Lado about 1.5 miles east of Priest Creek at mouth to Dolores River.
DRDOL39T	37-34-59.12 N	108-17-47.5 W	Garrison Canyon Drainage and flows from Sutton and Knuckles Reservoir.
DRDOL40T	37-44-43.5 N	108-14-50 W	Ground Hog Creek prior to Fish Creek
DRDOL41T	37-44-00 N	108-44-00 W	Fish Creek above confluence with Ground Hog Creek
DRDOL42T	37-42-15 N	108-00-00 W	Silver Creek above mines-upper station (will show background quality)
DRDOL43T	37-42-15 N	108-00-50 W	Silver Creek below settling ponds-midpoint station
DRDOL44T	37-42-01.30 N	108-01-42.5 W	Deadwood Gulch Flow

STATION	LATITUDE	LONGITUDE	DESCRIPTION
DRDOL45T	NW1/4 SE1/4	SEC 5 T37 R14	Italian Canyon flow
DRDOL46T	NE1/4 SE1/4	SEC 33 T38 R14	Dolores River 1/2 mile below Station DRDOL30T
DRDOL47T	37-42-30.0	108-01-42.0	Abandoned geothermal well by Argentina Mine above Rico
DRDOL48T	37-43-25.0	108-01-50.0	Poor Boy Mine drainage
DRDOL49T	37-41-46.25	108-02-1.25	Dolores River just below confluence with Silver Creek (D-4)
DRDOL50T	37-41-20 N	107-01-42.5 W	Dolores River 2-miles above Rico (D-2)
DRDOL51T	37-38-28.5 N	108-02-7.5 W	Dolores River below Rico between tailings and old dump (at graveyard)
DRDOL52T	37-34-26 N	108-11-02 W	Dolores River below confluence with Bear Creek

SEDIMENT STATIONS:

STATION	LATITUDE	LONGITUDE	DESCRIPTION
D-1	37-46-37.5 N	107-58-43.7 W	Dolores River just above confluence with Barlow Ck.(DRDOL02T)
D-10	37-35-17.5 N	108-21-08.75 W	Dolores River about 1/8 mi. above confluence with W Dolores R
D-11	37-28-28.75 N	108-30-09.63 W	Dolores River at Dolores
D-12			Dolores River at Peterson Slide (DRDOL03T)
D-13			Dolores River at Dolores (D-11) (DRDOL12T)
D-14			Dolores River 1/2 mile below DRDOL30T (DRDOL46T)
D-15			West Dolores River near the mouth (DRDOL24T)
D-16			Dolores River below confluence with Bear Creek (DRDOL52T)
D-2	37-41-20.0 N	108-01-42.5 W	Dolores River 2-miles above Rico
D-3	37-43-25.0 N	108-01-50.0 W	Dolores River at the bridge above Rico (DRDOL11T)
D-4	37-41-46.25 N	108-02-01.25 W	Dolores River just below confluence with Silver Ck.
D-5	37-42-01.25 N	108-01-42.5 W	Silver Ck. near the mouth at bridge (DRDOL10T)
D-6	37-38-28.5 N	108-02-07.5 W	Dolores River below Rico at graveyard
D-7	37-39-53.75 N	108-02-30.0 W	Dolores River just above confluence with Scotch Ck.
D-8	37-39-38.7 N	108-02-37.5 W	Scotch Ck. near the mouth just above the bridge (DRDOL07T)
D-9	37-38-31.25 N	108-02-07.5 W	Dolores River at the Montelores Bridge (DRDOL08T)

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-600/3-77-063	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE MERCURY DISTRIBUTION IN SOIL AROUND A LARGE COAL-FIRED POWER PLANT		5. REPORT DATE May 1977
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Alan B. Crockett and Robert R. Kinnison		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Environmental Monitoring and Support Laboratory Office of Research and Development U.S. Environmental Protection Agency Las Vegas, Nevada 89114		10. PROGRAM ELEMENT NO. 1HD620
		11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Environmental Protection Agency-Las Vegas, NV Office of Research and Development Environmental Monitoring and Support Laboratory Las Vegas, Nevada 89114		13. TYPE OF REPORT AND PERIOD COVERED Final
		14. SPONSORING AGENCY CODE EPA/600/07

15. SUPPLEMENTARY NOTES

16. ABSTRACT

Seventy soil samples were collected on a radial grid employing sixteen evenly spaced radii and five logarithmically spaced circles, concentric around the Four Corners power plant. The soil samples were analyzed for total mercury using a Zeeman Atomic Absorption spectrophotometer. Residue levels were quite low compared to average soil residues and no statistically valid differences in mercury residue levels were detected between circles or radii using two-way analysis of variance techniques. F-ratios indicated: significant differences between circles, significant differences between radii, and significant complex interaction which could not be eliminated. Contours of iso-mercury concentrations show a relative high west of the plant near the ash ponds and another just east of the plant. The fate of the 510 kg of mercury emitted per year is not known, but it is not accumulating near the plant. Mercury emissions by U.S. coal-fired power plants amount to only 4% of the natural degassing loss in the U.S., and levels near power plants appear low. The significance of mercury emissions by power plants should be evaluated on a regional basis since the evidence shows no significant local elevation of mercury in soils or air.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Mercury* residues monitoring soil* power plants*	Four Corners, NM coal-fired power plants	07E 08M 10E 18B 18H

18. DISTRIBUTION STATEMENT RELEASE TO PUBLIC	19. SECURITY CLASS *(This Report)* UNCLASSIFIED	21. NO. OF PAGES 14
	20. SECURITY CLASS *(This page)* UNCLASSIFIED	22. PRICE A02-A01

EPA Form 2220-1 (9-73)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
Western Colorado Office
764 Horizon Drive, South Annex A
Grand Junction, Colorado 81506-3946

U.S. FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES
764 Horizon Dr/So. Annex A
Grand Junction, CO 81506-3946

Official Business
Penalty For Private Use $300

IN REPLY REFER TO:

ES/CO:Nonfederal Informal Consultation
MS 65412 GJ

RECEIVED
MAY 26 1994
URS/ARCS

May 24, 1994

Michael Carr
Project Manager
URS Consultants Inc.
1099 18th Street, Suite 700
Denver, Colorado 80202-1907

Dear Mr. Carr:

This responds to your letter of April 20, 1994, requesting information on federally listed species in the Rico area. The following is a list of those species which may inhabit the area, or be effected by the proposed project.

Be advised that the Fish and Wildlife Service (Service) can enter into formal section 7 consultation only with another Federal agency or its designee. Thus, this is not to be considered an "official species list" but rather informal consultation. Informal consultation includes all contacts, discussions, correspondence, etc. between the Federal agency or its designated nonfederal representative, and the Service, that take place prior to the initiation of any necessary formal consultation. If requested, we will submit an official list to the lead Federal agency. That agency would be required under section 7 (a) (2) of the Act to initiate formal consultation if it determines that its action may affect any listed species or its critical habitat. Although applicants may fill the role of nonfederal representatives, the ultimate responsibility for compliance with section 7 remains with the Federal agency.

FEDERALLY LISTED SPECIES

Bald eagle	*Haliaeetus leucocephalus*
Peregrine falcon	*Falco peregrinus*
Mexican spotted owl	*Strix occidentalis lucida*
Colorado squawfish	*Ptychocheilus lucius*
Humpback chub	*Gila cypha*
Bonytail chub	*Gila elegans*
Razorback sucker	*Xyrauchen texanus*

We would like to bring to your attention species which are candidates for official listing as threatened or endangered species (Federal Register, Vol. 56, No. 225, November 21, 1991). While these species presently have no legal protection under the Endangered Species Act (Act), it is within the spirit of the Act to consider project impacts to potentially sensitive candidate species. Additionally, we wish to make you aware of the presence of Federal

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candidates should any be proposed or listed prior to the time that all Federal actions related to the project are completed.

FEDERAL CANDIDATE SPECIES

North American wolverine	*Gulo gulo luscus*
Northern goshawk	*Accipiter gentilis*
Flannelmouth sucker	*Catostomus latipinnis*
Roundtail chub	*Gila robusta*

The endangered and candidate fish species listed above do not occur in the project area, however, we consider the depletion of water from the upper Colorado River an adverse impact to the habitat for these species. Consequently, any activity authorized by the Environmental Protection Agency (EPA) that results in a net depletion of water from the upper Colorado River basin should trigger a "may affect" finding by the EPA and formal consultation with this office under authority of the Endangered Species Act.

We appreciate the opportunity to provide this information. If the Service can be of further assistance, please contact Michael Tucker at the letterhead address or (303) 243-2778.

Sincerely,

Keith L. Rose

Keith L. Rose
Assistant Field Supervisor, Colorado

pc: FWS/ES, Golden
CDOW, Montrose

MTucker:RicoSpl.ltr:052494

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
Colorado Field Office
730 Simms Street, Suite 290
Golden, Colorado 80401

IN REPLY REFER TO:
ES/CO:Species List
Mail Stop 65412

JUN 17 1994

Michael V. Carr, Project Manager
URS Consultants, Inc.
1099 18th Street, Suite 700
Denver, Colorado 80202-1907

Dear Mr. Carr:

In response to your letter dated April 20, 1993, the U.S. Fish and Wildlife Service (Service) is providing the species list you requested for the Brighton-Ft. Lupton Landfill located in Weld County and the Rico-Argentine Mine located in Dolores County, Colorado. The following list of threatened, endangered, and candidate species should be helpful in your preparation of the environmental assessment for the project sites. These comments have been prepared under the provisions of the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 et. seq.).

The federally listed threatened and endangered species that could occur at or visit the proposed sites are:
(Weld County = W; Dolores County = D)

Birds: Bald eagle, *Haliaeetus leucocephalus*, Endangered (W,D)
Whooping crane, *Grus americana*, Endangered (W)
Least tern, *Sterna antillarium*, Endandered (W)
Piping plover, *Charadrius melodus*, Threatened (W)
Southwestern willow flycatcher, *Empidonax traillì extimus*, Proposed Endangered (D)
Mexican spotted owl, *Strix occidentalis lucida*, Threatened (D)

Mammals: Black-footed ferret, *Mustela nigripes*, Endangered (W,D)

Plants: Ute ladies'-tresses orchid, *Spiranthes diluvialis*, Threatened (W)

The Service also is interested in the protection of species which are candidates for official listing as threatened or endangered (<u>Federal Register</u>, Vol. 56, No. 225, November 21, 1991; Vol. 55, No. 35, February 21, 1990). While these species presently have no legal protection under the ESA, it is within the spirit of this act to consider project impacts to potentially sensitive candidate species. It is the intention of the Service to protect these species before human-related activities adversely impact their habitat to a degree that they would need to be listed and, therefore, protected under the ESA. Additionally, we wish to make you aware of the presence of Federal candidates should any be proposed or listed prior to the time that all Federal actions related to the project are completed. If any candidate species will be unavoidably impacted, appropriate mitigation should be proposed and discussed with this office.

The list of Federal candidate species that could occur at or visit the proposed site include:

Birds:	Black Tern, *Chlidonias niger*, Category 2 (W,D) Ferruginous hawk, *Buteo regalis*, Category 2 (W) White-faced ibis, *Plegadis chihi*, Category 2 (W) Mountain plover, *Charadrius montanus*, Category 1 (W) Baird's Sparrow, *Ammodramus bairdii*, Category 2 (W) Northern goshawk, *Accipiter gentilis*, Category 2 (D)
Mammals:	Preble's meadow jumping mouse, *Zapus hudsonius preblei*, Category 2 (W) Swift fox, *Vulpes velox*, Category 2 (W) Fringed-tailed myotis, *Myotis thysanodes pahasapensis*, Category 2 (W) North American wolverine, *Gulo gulo luscus*, Category 2 (D)
Fishes:	Plains topminnow, *Fundulus sciadicus*, Category 2 (W) Colorado River cutthroat trout, *Oncorhynchus clarki pleuriticus*, Category 2 (D) Round tail chub, *Gila robusta*, Category 2 (D) Flannelmouth sucker, *Catostomus latipinnis*, Category 2 (D)
Plants:	Colorado butterflyweed, *Gaura neomexicana ssp. coloradensis*, Category 1 (W) Dwarf milkweed, *Asclepias uncialis*, Category 2 (W) Showy prairie gentian, *Eustoma grandiflorum*, Category 2 (W)
Insects:	Regal fritillary butterfly, *Speyeria idalia*, Category 2 (W)

If the Service can be of further assistance, contact Clay Ronish of this office at (303) 231-5280.

Sincerely,

LeRoy W Carlson

LeRoy W. Carlson
Colorado Field Supervisor

cc: AFS, Grand Junction, CO
Reading file
Project file

Reference:
CRR*SPECLIST.88

[illegible]

Send letter rescinding FOIA request

cc: Gary Sink / EPA (warn)

PERMIT	D CO OWNER INFORMATION / ACTIVITY CD	ACTIVITY DATE	STATUS CD	STATUS DATE	WD	MD	DB	USE	1ST USED DATE	ANNUAL APROP	ACRES IRR	GEOL AQFR	WELL YIELD	WELL DEPTH	WATER LEVEL	SEC LOCAT'N COORDINATES	QTRS	SC	TOWN SHIP	RANGE	P M
12204	7 42 TRUELSON LOWELL DOLORES, CO 81323																				
					34			8					55.00	30	12		SWSW	~~29~~	~~39 N~~	~~11 W~~	~~N~~
41304F	7 17 FITZGERALD JOHN P O BOX 692 TELLURIDE, CO 81435															out of 4-mile					
	EX	04/23/92	AR	05/26/92	71			8				GW				2350N,1250E	SENE	1	40 N	11 W	N
81412	7 17 MCCOLLUM O. D. 1902 WILLOW DR. ABILENE, TX 79602																				
					69			H	09/05/76				15.00	52	37		NENE	~~6~~	~~40 N~~	~~11 W~~	~~N~~
164989	7 17 ADELSON DIANE P O BOX 1434 TELLURIDE, CO 81435																				
	NP	06/15/92			71			8 L				GW				0850N,0400W	NWNW	~~6~~	~~40 N~~	~~11 W~~	~~N~~
	7 17 BURCH WILLIAM F & GAIL J 1740 MANHATTAN BCH BLVD MANHATTAN BCH, CA 90266																				
	AP	04/04/94			71			8				GW				0900N,0800W	NWNW	~~6~~	~~40 N~~	~~11 W~~	~~N~~
41023F	7 17 DAVIS JOHN & KATHLEEN P O BOX 222 BAGDAD, AZ 86321																				
	NP	11/12/91	AU	12/10/91	71			8				GW				3000S,3050E	SENW	~~6~~	~~40 N~~	~~11 W~~	~~N~~
41668	7 17 GO INTERNATIONAL INC P O BX 1936 FORT WORTH, TX 76107																				
					69			8	07/15/70				10.00	57	28		SENW	~~6~~	~~40 N~~	~~11 W~~	~~N~~
158777	7 17 JAHNKE ORVAL L & MARY B HWY 145 P O BOX 156 RICO, CO 81332																				
	NP	09/10/90	AR	11/05/90	71			H				GW	4.00	160	35	1750S,0650E	NESE	23	40 N	11 W	N
90477VE	7 17 JAHNKE ORVAL , 00000																				
	AV	10/03/90			71			~~H~~				GW					NESE	23	40 N	11 W	N
68951	7 17 MOORE PAUL E 4906 ROCKLEDGE DR RIVERSIDE, CA 92506																				
					69			H	05/22/73				6.00	49	37	0550S,0500E	SESE	23	40 N	11 W	N
	7 17 RICO DEVELOPMENT P O BOX 130 RICO, CO 81332																				
	AP	11/03/88	AU	04/17/89	71			4	industrial			GW				0250N,0600W	NWNW	25	40 N	11 W	N
391	7 17 CO DIV HIGHWAYS 6TH. & RAILROAD AVE. DURANGO, CO 81301																				
	NP	10/09/84			71			O	other				15.00	70	55	2300S,0300W	NWSW	25	40 N	11 W	N
145683	7 17 MAXWELL MICHAEL G. PO BOX 217 RICO, CO 81332 LOT 17 BLK 36 RICO, TOWN OF																				
	NP	09/24/86			71			H				KD				1990N,0775E	SENE	35	40 N	11 W	N
	7 17 LAFAYETTE W J RICO, CO 81332																				
	AP	06/24/83			71							GEO					NW	36	40 N	11 W	N
149181	7 17 US FOREST SERVICE LAKEWOOD, CO 80225																				
	NP	05/19/87			71			8				GW	4.00	107			SWNE	27	~~41 N~~	~~11 W~~	~~N~~
113999	7 17 US FOREST SERVICE 11177 W 8TH AVE LAKEWOOD, CO 80225																				
	NP	04/18/80	SU	11/24/89	71			8					12.00	89	15	0660S,1980W	SESW	28	~~41 N~~	~~11 W~~	~~N~~
149893	7 17 DOLORES CANYON MINES 1551 S.BROADWAY CORTEZ, CO 81321																				
	NP	10/28/87			71			8				GW					SESE	32	~~41 N~~	~~11 W~~	~~N~~
11449AD	7 17 DOLORES CANYON MINES INC. CORTEZ, CO 81321																				
	AD	09/15/87			71			O				GW					SESE	32	~~41 N~~	~~11 W~~	~~N~~
20275MH	7 17 GEYSER RIVER CORP % GROUNDWATER DEVEL INC MONTROSE, CO 81402																				
	MH	01/25/93			71			O M				GW					SESE	34	~~41 N~~	~~11 W~~	~~N~~
90775	4 57 SCHWINN RICHARD BOX 1054 TELLURIDE, CO 81435																				
					60			8	06/24/77				5.00	130	51	2400S,1250E	NESE	3	~~42 N~~	~~11 W~~	~~N~~

3 household
1 industrial
1 other

toilet, washbasin in maintenance shop -
truck cleaning now, only used for a few years
Vickers, Ted.

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PERMIT	D	CO	OWNER INFORMATION	ACTIVITY CD	ACTIVITY DATE	STATUS CD	STATUS DATE	WD	MD	DB	USE	1ST USED DATE	ANNUAL APROP	ACRES IRR	GEOL AQFR	WELL YIELD	WELL DEPTH	WATER LEVEL	SEC COORDINATES	QTRS	SC	TOWN SHIP	RANGE	P M	
	3	2	WELLS FARGO AG ENGLEWOOD, CO 80155	AP	04/12/84	AU	03/30/88	20			1									SESW	33	39 N	10 W	N	out of 4-mile
18516F	3	2	BEIRIGER FLOYD HOOPER, CO 81136	NP	05/29/74	EP	06/19/75	20			1									NWSE	6	40 N	10 W	N	
40345	7	17	POWELL RONALD RT 1 BOX 232 MONTROSE, CO 81401					69			8	02/13/70				12.00	40	14		SESE	~~23~~	~~40 N~~	~~10 W~~	~~N~~	
21171MH	3	55	U S GEOLOGICAL SURVEY 201 W 8TH ST #200 PUEBLO, CO 81003-3031	MH	07/27/93			27			O M				GW					NE	~~20~~	~~41 N~~	~~10 W~~	~~N~~	
103821	7	17	US FOREST SERVICE 11177 W 8TH AVE LAKEWOOD, CO 80225	NP	11/20/78			69			O					5.00	92		2300S,2400E	NWSE	33	~~41 N~~	~~10 W~~	~~N~~	
18632MH	4	57	DEAVERS KAREY C/O 2285 U075 RD CEDAREDGE, CO 81413	MH	02/04/92			60			O				GW	3.00	606	520	2440S,0200E	NESE	4	~~42 N~~	~~10 W~~	~~N~~	
19573MH	4	57	AJAX DEVELOPMENT CO % B F KISSNER DRILLING CEDAREDGE, CO 81413	MH	08/21/92			60			O M				GW					SESW	4	~~42 N~~	~~10 W~~	~~N~~	
12520AD	4	57	RINGQUIST LOEY P O BOX 429 NORWOOD, CO 81423	AD	03/21/91			60			2				GW				0300S,2800E	SESW	5	~~42 N~~	~~10 W~~	~~N~~	
31951F	4	57	WILSON MESA METRO DISTRICT 624 NORTH ST ASPEN, CO 81611 FLG 1 WILSON MESA RANCHES	EP	06/18/87	PI	06/30/88	60			8				KD				1700N,2500E	SENE	6	~~42 N~~	~~10 W~~	~~N~~	
156866	4	57	HOFFMAN DAVID I P O BOX 1438 TELLURIDE, CO 81435 LOT 8 FLG 1 WILSON MESA RANCHES	NP	03/19/90	EP	04/24/92	60			H				GW				0713N,1161W	NWNW	6	~~42 N~~	~~10 W~~	~~N~~	
145014	4	57	CLARKE CHARLES RIDGWAY, CO 81432 LOT 13 FLG 2 WILSON MESA RANCH	NP	07/30/86	PI		60			H				KD					SENW	6	~~42 N~~	~~10 W~~	~~N~~	
585	4	57	RIGGS ANNE WILSON MESA TELLURIDE, CO 81435					60			H	07/19/76				15.00	180	140	1450N,2350W	SENW	~~6~~	~~42 N~~	~~10 W~~	~~N~~	
112080	4	57	GRISIER J R GRAND JCTN, CO 81501	NP	11/30/79			60			H									SESE	~~6~~	~~42 N~~	~~10 W~~	~~N~~	
90774	4	57	DEFELICE FREDERICK W. BOX 81 TELLURIDE, CO 81435					60			H	10/08/77				5.00	180	150	4150N,1200W	SWSW	~~6~~	~~42 N~~	~~10 W~~	~~N~~	
85049	4	57	GLEASON HART & PATSY BOX 322 PLACERVILLE, CO 81430					60			H	08/01/76				15.00	10	8	0675N,2300E	NWNE	7	~~42 N~~	~~10 W~~	~~N~~	
93003	4	57	SCHWEPPE CHARLES H BOX 1085 TELLURIDE, CO 81435 LOT 58 FLG 5 WILSON MESA RANCH	NP	06/08/77			60			H	10/01/77				5.00	180	21	0400S,1320W	SESW	7	~~42 N~~	~~10 W~~	~~N~~	
6842AD	4	57	SCHWEPPE CHARLES H. TELLURIDE, CO 81435	AD				60			H									SWSW	7	~~42 N~~	~~10 W~~	~~N~~	
161758	4	57	FILLHART LARRY P O BOX 1143 TELLURIDE, CO 81425	NP	08/15/91			60			8 L				KD				1800S,0800E	NESE	8	~~42 N~~	~~10 W~~	~~N~~	
20300MH	4	57	AJAX DEVELOPMENT % B F KISSNER DRILLING CEDAREDGE, CO 81413	MH	02/05/93			60			O M				GW	12.00	251	147		NENE	9	~~42 N~~	~~10 W~~	~~N~~	
170312	4	57	ALLAIRE PAUL A P O BOX 1600 STAMFORD, CT 06904 LOT 7 PTARMIGAN	NP	05/19/93			60			8 L				KD	12.00	246	147	0600N,1300E	NENE	9	~~42 N~~	~~10 W~~	~~N~~	

none

COLORADO DIVISION OF WATER RESOURCES

PERMIT	D	CO	OWNER INFORMATION	ACTIVITY CD	ACTIVITY DATE	STATUS CD	STATUS DATE	WD	MD	DB	USE	1ST USED DATE	ANNUAL APROP	ACRES IRR	GEOL AQFR	WELL YIELD	WELL DEPTH	WATER LEVEL	SEC LOCAT'N COORDINATES	QTRS	SC	TOWN SHIP	RANGE	P M
98870	7	34	DOWNING D ROUTE 2 BOX 3 DURANGO, CO 81301																					
				NP	05/03/78			30			8								~~2200S,2000E~~	~~NWSE~~	~~16~~	~~38 N~~	~~10 W~~	~~N~~
	3	2	WELLS FARGO AG ENGLEWOOD, CO 80155																					
				AP	04/12/84	AU	03/30/88	20			1									CSE	~~22~~	~~39 N~~	~~10 W~~	~~N~~
	3	2	WELLS FARGO AG ENGLEWOOD, CO 80155																					
				AP	04/12/84	AU	03/30/88	20			1									NESW	~~28~~	~~39 N~~	~~10 W~~	~~N~~
	3	2	WELLS FARGO AG ENGLEWOOD, CO 80155																					
				AP	04/12/84	AU	03/30/88	20			1									NWSE	~~29~~	~~39 N~~	~~10 W~~	~~N~~
	3	2	WELLS FARGO AG ENGLEWOOD, CO 80155																					
				AP	04/12/84	AU	03/30/88	20			1									SESW	~~32~~	~~39 N~~	~~10 W~~	~~N~~
	3	2	WELLS FARGO AG ENGLEWOOD, CO 80155																					
				AP	04/12/84	AU	03/30/88	20			1									SENW	~~33~~	~~39 N~~	~~10 W~~	~~N~~
	3	2	WELLS FARGO AG ENGLEWOOD, CO 80155																					
				AP	04/12/84	AU	03/30/88	20			1									SESW	~~33~~	~~39 N~~	~~10 W~~	~~N~~
18516F	3	2	BEIRIGER FLOYD HOOPER, CO 81136																					
				NP	05/29/74	EP	06/19/75	20			1									NWSE	16	40 N	10 W	N
40345	7	17	POWELL RONALD RT 1 BOX 232 MONTROSE, CO 81401																					
								69			8	02/13/70				12.00	40	14		SESE	23	40 N	10 W	N
21171MH	3	55	U S GEOLOGICAL SURVEY 201 W 8TH ST #200 PUEBLO, CO 81003-3031																					
				MH	07/27/93			27			O M				GW					NE	20	41 N	10 W	N
103821	7	17	US FOREST SERVICE 11177 W 8TH AVE LAKEWOOD, CO 80225																					
				NP	11/20/78			69			O					5.00	92		2300S,2400E	NWSE	33	41 N	10 W	N
532MH	4	57	DEAVERS KAREY C/O 2285 U075 RD CEDAREDGE, CO 81413																					
				MH	02/04/92			60			O				GW	3.00	606	520	2440S,0200E	NESE	4	42 N	10 W	N
19573MH	4	57	AJAX DEVELOPMENT CO % B F KISSNER DRILLING CEDAREDGE, CO 81413																					
				MH	08/21/92			60			O M				GW					SESW	4	42 N	10 W	N
12520AD	4	57	RINGQUIST LOEY P O BOX 429 NORWOOD, CO 81423																					
				AD	03/21/91			60			2				GW				0300S,2800E	SESW	5	42 N	10 W	N
31951F	4	57	WILSON MESA METRO DISTRICT 624 NORTH ST ASPEN, CO 81611 FLG 1 WILSON MESA RANCHES																					
				EP	06/18/87	PI	06/30/88	60			8				KD				1700N,2500E	SENE	6	42 N	10 W	N
156866	4	57	HOFFMAN DAVID I P O BOX 1438 TELLURIDE, CO 81435 LOT 8 FLG 1 WILSON MESA RANCHES																					
				NP	03/19/90	EP	04/24/92	60			H				GW				0713N,1161W	NWNW	6	42 N	10 W	N
145014	4	57	CLARKE CHARLES RIDGWAY, CO 81432 LOT 13 FLG 2 WILSON MESA RANCH																					
				NP	07/30/86	PI		60			H				KD					SENW	6	42 N	10 W	N
85585	4	57	RIGGS ANNE WILSON MESA TELLURIDE, CO 81435																					
								60			H	07/19/76				15.00	180	140	1450N,2350W	SENW	6	42 N	10 W	N
112080	4	57	GRISIER J R GRAND JCTN, CO 81501																					
				NP	11/30/79			60			H									SESE	6	42 N	10 W	N
90774	4	57	DEFELICE FREDERICK W. BOX 81 TELLURIDE, CO 81435																					
								60			H	10/08/77				5.00	180	150	4150N,1200W	SWSW	6	42 N	10 W	N

none

PERMIT	ACTIVITY CD	ACTIVITY DATE	STATUS CD	STATUS DATE	WD	MD	DB	USE	1ST USED DATE	ANNUAL APROP	ACRES IRR	GEOL AQFR	WELL YIELD	WELL DEPTH	WATER LEVEL	SEC LOCAT'N COORDINATES	QTRS	SC	TOWN SHIP	RANGE	P M
PERMIT	D CO OWNER INFORMATION																				
154498	A 3 2 TREJO JANELLE P O BOX 960 ALAMOSA, CO 81101 LOT 3 PLEASANT ACRES																				
	NP	06/21/89	EP	06/23/91	20			8				UNC				~~4000S,2010W~~	~~NENW~~	~~31~~	~~38 N~~	~~11 W~~	~~N~~
127473	7 42 SNYDER R A BOX 1178 CORTEZ, CO 81321																				
	NP	08/16/82	AR	09/20/82	71			H					12.00	69	6	1320N,2640E	NWNE	28	~~39 N~~	~~11 W~~	~~N~~
150468	7 42 NORTH OUIDA M. DOLORES, CO 81323																				
	NP	09/02/86			71			3				GW	10.00	84	40		NWSW	~~28~~	~~39 N~~	~~11 W~~	~~N~~
153981	7 42 STARKS ILA M & RUBY M MEHRER 217 NORTH HENRY CORTEZ, CO 81321																				
	NP	09/02/86	EP	05/03/91	71			8 L				GW				0644S,1930E	SWSE	~~29~~	~~39 N~~	~~11 W~~	~~N~~
41311F	7 42 HOY ROBERT E P O BOX 1258 DOLORES, CO 81323																				
	NP	05/29/92	EP	11/03/92	71			8				GW	50.00	60	10	0800S,2000E	SWSE	~~29~~	~~39 N~~	~~11 W~~	~~N~~
88290	7 42 STARKS JAMES H & ILA M BOX 186 RICO, CO 81332																				
					69			H	03/01/77				5.00	200	50	1200S,1420E	SWSE	~~29~~	~~39 N~~	~~11 W~~	~~N~~
43068F	7 42 HOY ROBERT E P O BOX 1258 DOLORES, CO 81323																				
	NP	11/19/93			71			8 A				GW	15.00	60	8	0800S,2000E	SWSE	~~29~~	~~39 N~~	~~11 W~~	~~N~~
12204	7 42 TRUELSON LOWELL DOLORES, CO 81323																				
					34			8					55.00	30	12		SWSW	~~29~~	~~39 N~~	~~11 W~~	~~N~~
41304F	7 17 FITZGERALD JOHN P O BOX 692 TELLURIDE, CO 81435																				
	EX	04/23/92	AR	05/26/92	71			8				GW				2350N,1250E	SENE	1	40 N	11 W	N
81412	7 17 MCCOLLUM O. D. 1902 WILLOW DR. ABILENE, TX 79602																				
					69			H	09/05/76				15.00	52	37		NENE	6	40 N	11 W	N
164989	7 17 ADELSON DIANE P O BOX 1434 TELLURIDE, CO 81435																				
	NP	06/15/92			71			8 L				GW				0850N,0400W	NWNW	6	40 N	11 W	N
	7 17 BURCH WILLIAM F & GAIL J 1740 MANHATTAN BCH BLVD MANHATTAN BCH, CA 90266																				
	AP	04/04/94			71			8				GW				0900N,0800W	NWNW	6	40 N	11 W	N
41023F	7 17 DAVIS JOHN & KATHLEEN P O BOX 222 BAGDAD, AZ 86321																				
	NP	11/12/91	AU	12/10/91	71			8				GW				3000S,3050E	SENW	6	40 N	11 W	N
41668	7 17 GO INTERNATIONAL INC P O BX 1936 FORT WORTH, TX 76107																				
					69			8	07/15/70				10.00	57	28		SENW	6	40 N	11 W	N
158777	7 17 JAHNKE ORVAL L & MARY B HWY 145 P O BOX 156 RICO, CO 81332																				
	NP	09/10/90	AR	11/05/90	71			H				GW	4.00	160	35	1750S,0650E	NESE	23	40 N	11 W	N
90477VE	7 17 JAHNKE ORVAL , 00000																				
	AV	10/03/90			71			H				GW					NESE	23	40 N	11 W	N
68951	7 17 MOORE PAUL E 4906 ROCKLEDGE DR RIVERSIDE, CA 92506																				
					69			H	05/22/73				6.00	49	37	0550S,0500E	SESE	23	40 N	11 W	N
	7 17 RICO DEVELOPMENT P O BOX 130 RICO, CO 81332																				
	AP	11/03/88	AU	04/17/89	71			4				GW				0250N,0600W	NWNW	25	40 N	11 W	N
139391	7 17 CO DIV HIGHWAYS 6TH. & RAILROAD AVE. DURANGO, CO 81301																				
	NP	10/09/84			71			O					15.00	70	55	2300S,0300W	NWSW	25	40 N	11 W	N
145683	7 17 MAXWELL MICHAEL G. PO BOX 217 RICO, CO 81332 LOT 17 BLK 36 RICO, TOWN OF																				
	NP	09/24/86			71			H				KD				1990N,0775E	SENE	36	40 N	11 W	N

None

START --> W A T E R   R I G H T S   R E P O R T

for REC,   04/06/94   14:59

Title: Division 7

Sort Sequence: LOCATION

E X P L A N A T I O N   O F   C O D E S

Struct Type: D ditch, E seep, L pipeline, M mine, O other P pump, R reservoir, S spring, W well, Z power plant, * means more than three structure types are decreed

Use Codes: A augmentation, B basin export, C commercial, D domestic, E evaporation, F fire, f forest, G geothermal, H household use only, I irrigation,
K snowmaking, M municipal, m minimum streamflow, N industrial, O other, P fishery, p power generation, R recreation, r recharge, S stock,
W wildlife, X all beneficial uses, * means more than three uses are decreed

Adj Type: AB abandoned, AP alternate point, C conditional, CA conditional made absolute, EX exchange, O original, S supplemental, TF transfer from, TT transfer to

Admin Number is a number developed by DWR to provide a simple and efficient method of ranking decrees in order of seniority.

WD	ID#	Name of Structure	Struct Type	Stream #	Stream Name	Cty	Q-Q-Q	Sec	Ts	Rng	PM	Use Codes	Decreed Amount	U	Adj Type	Adjudicatn Date	Prev Adj Date	Approprn Date	O #	Admin Number	Priority Number	Court Case	Seq#	P A	Alter ID#	Comment
~~71~~	~~508~~	~~BEMIS SPRING AREA~~	~~S~~	~~14~~	~~EAST FORK DOLORES R~~	~~17~~	~~NWNWNE~~	~~24~~	~~40 N~~	~~11 W~~	~~N~~	~~IN*~~	0.0266	C	S	12/31/1972	12/31/1971	12/31/1900		44559.18627		W 810	1			
~~71~~	~~578~~	~~PIEDMONT SPRINGS~~	S	14	EAST FORK DOLORES R	~~17~~	~~SWNENW~~	~~24~~	~~40 N~~	~~11 W~~	~~N~~	~~NF*~~	0.0240	C	S	12/31/1972	12/31/1971	12/31/1926		44559.28123		W 809	1			
~~71~~	~~574~~	~~MOUNTAIN SPRINGS TUNNEL~~	DM	14	EAST FORK DOLORES R	~~17~~	~~NWSWSE~~	~~24~~	~~40 N~~	~~11 W~~	~~N~~	~~IN*~~	0.0177	C	O	12/31/1972		12/31/1930		29584.00000		W 811	1			
71	566	MARY B SPRING	S	14	EAST FORK DOLORES R	17	NESENW	25	40 N	11 W	N	IF*	0.0599	C	S	12/31/1972	12/31/1971	06/30/1970		44559.44010		W 807	1			
71	602	ST LOUIS TUNNEL	M	14	EAST FORK DOLORES R	17	SWNENW	25	40 N	11 W	N	NDS	1.1942	C	S	12/31/1972	12/31/1971	12/31/1929		44559.29219		W 802	1			
71	5006	DDH-OS4 ART DRILL HOLE	W	14	EAST FORK DOLORES R	17	SWNESW	25	40 N	11 W	N	N	0.0550	C	O	12/31/1972		10/31/1970		44133.00000		W 800	1			
71	5007	DDH-OS5A ART DRILL HOLE	W	14	EAST FORK DOLORES R	17	SWNESW	25	40 N	11 W	N	N	0.0550	C	O	12/31/1972		11/30/1971		44528.00000		W 799	1			
71	629	COLUMBIA SPRING NO 2	S	14	EAST FORK DOLORES R	17	SESWNE	26	40 N	11 W	N	NS	0.0330	C	S	12/31/1975	12/31/1974	07/15/1967		45655.42929		W 1387	1			
71	628	COLUMBIA SPRING NO 1	S	14	EAST FORK DOLORES R	17	NWNESE	26	40 N	11 W	N	NS	0.0220	C	S	12/31/1975	12/31/1974	07/15/1967		45655.42929		W 1386	1			
71	1902	SILVER CREEK		1	DOLORES RIVER	17	SESESE	26	40 N	11 W	N	O	2.0000	C	S	12/31/1983	12/31/1982	05/05/1983		48702.00000		83 88	1			CWCB MIN FLOW LOCATION DWNSTR TERMINUS FROM USFS MAPPING
71	550	IRON CLAD TUNNEL	M	14	EAST FORK DOLORES R	17	SWSENE	35	40 N	11 W	N	NF*	0.0610	C	S	12/31/1972	12/31/1971	12/31/1948		44559.36159		W 792	1			
71	542	GINIA SPRING	S	14	EAST FORK DOLORES R	17	SWSENW	35	40 N	11 W	N	NF*	0.0888	C	S	12/31/1972	12/31/1971	12/31/1948		44559.36159		W 791	1			
71	519	COWDREY SPRING	S	14	EAST FORK DOLORES R	17	SWSWSE	35	40 N	11 W	N	NS	0.0330	C	S	12/31/1972	12/31/1971	06/10/1972		44721.00000		W 804	1			
71	597	SILVER SWAN SPRING	S	14	EAST FORK DOLORES R	17	SWSWSE	35	40 N	11 W	N	NS	0.0118	C	S	12/31/1972	12/31/1971	06/10/1972		44721.00000		W 805	1			
71	598	SILVER SWAN TUNNEL	M	14	EAST FORK DOLORES R	17	SWSESE	35	40 N	11 W	N	NF*	0.0599	C	S	12/31/1972	12/31/1971	12/31/1900		44559.18627		W 798	1			
71	581	PRO PATRIA TUNNEL	ML	14	EAST FORK DOLORES R	17	SWNENE	36	40 N	11 W	N	NFS	0.0220	C	S	12/31/1972	12/31/1971	12/31/1926		44559.28123		W 812	1			
71	583	RAMCO NO 21 SPRING	S	14	EAST FORK DOLORES R	17	SENWNW	1	39 N	11 W	N	NS	0.0067	C	S	12/31/1972	12/31/1971	12/31/1929		44559.29219		W 803	1			
71	622	WAMBA SPRING	S	14	EAST FORK DOLORES R	17	SWNWNE	2	39 N	11 W	N	NS	0.0028	C	S	12/31/1972	12/31/1971	12/31/1926		44559.28123		W 797	1			
71	1911	SCOTCH CREEK	O	14	EAST FORK DOLORES R	17	SESESW	11	39 N	11 W	N	O	1.5000	C	S	12/31/1984	12/31/1983	07/13/1984		49137.00000		84 288	1			MIN FLOW USGS PROTRACTED LOCATION DS TERMINUS AT DOLORES RIVER
71	1907	DOLORES RIVER	O	14	EAST FORK DOLORES R	17	SENESE	15	39 N	11 W	N	O	20.0000	C	S	12/31/1984	12/31/1983	07/13/1984		49137.00000		84 284	1			UPPER REACH,USFS PROTRACTED LOCATION DS TERMINUS AT FILL GULCH
71	1913	WILDCAT CREEK	O	14	EAST FORK DOLORES R	42	NWNWNW	27	39 N	11 W	N	O	1.0000	C	S	12/31/1984	12/31/1983	07/13/1984		49137.00000		84 290	1			MIN FLOW,USGS PROTRACTED LOCATION DS TERMINUS AT DOLORES RIVER
71	508	BEMIS SPRING AREA	S	14	EAST FORK DOLORES R	17	NWNWNE	24	40 N	11 W	N	IN*	0.0266	C	S	12/31/1972	12/31/1971	12/31/1900		44559.18627		W 810	1			
71	578	PIEDMONT SPRINGS	S	14	EAST FORK DOLORES R	17	SWNENW	24	40 N	11 W	N	NF*	0.0240	C	S	12/31/1972	12/31/1971	12/31/1926		44559.28123		W 809	1			
71	574	MOUNTAIN SPRINGS TUNNEL	DM	14	EAST FORK DOLORES R	17	NWSWSE	24	40 N	11 W	N	IN*	0.0177	C	O	12/31/1972		12/31/1930		29584.00000		W 811	1			
71	566	MARY B SPRING	S	14	EAST FORK DOLORES R	17	NESENW	25	40 N	11 W	N	IF*	0.0599	C	S	12/31/1972	12/31/1971	06/30/1970		44559.44010		W 807	1			
71	602	ST LOUIS TUNNEL	M	14	EAST FORK DOLORES R	17	SWNENW	25	40 N	11 W	N	NDS	1.1942	C	S	12/31/1972	12/31/1971	12/31/1929		44559.29219		W 802	1			
71	5006	DDH-OS4 ART DRILL HOLE	W	14	EAST FORK DOLORES R	17	SWNESW	25	40 N	11 W	N	N	0.0550	C	O	12/31/1972		10/31/1970		44133.00000		W 800	1			
71	5007	DDH-OS5A ART DRILL HOLE	W	14	EAST FORK DOLORES R	17	SWNESW	25	40 N	11 W	N	N	0.0550	C	O	12/31/1972		11/30/1971		44528.00000		W 799	1			
71	629	COLUMBIA SPRING NO 2	S	14	EAST FORK DOLORES R	17	SESWNE	26	40 N	11 W	N	NS	0.0330	C	S	12/31/1975	12/31/1974	07/15/1967		45655.42929		W 1387	1			
71	628	COLUMBIA SPRING NO 1	S	14	EAST FORK DOLORES R	17	NWNESE	26	40 N	11 W	N	NS	0.0220	C	S	12/31/1975	12/31/1974	07/15/1967		45655.42929		W 1386	1			

con't next page

WD	ID#	Name of Structure	Struct Type	Stream #	Stream Name	Cty	Q-Q-Q	Sec	Ts	Rng	PM	Use Codes	Decreed Amount	U	Adj Type	Adjudicatn Date	Prev Adj Date	Appropm Date	O #	Admin Number	Priority Number	Court Case	Seq#	P A	Alter ID#	Comment
~~71~~	~~581~~	~~PRO PATRIA TUNNEL~~	ML	14	EAST FORK DOLORES R	17	SWNENE	36	40 N	11 W	N	NFS	0.0220	C	S	12/31/1972	12/31/1971	12/31/1926		44559.28123		W 812	1			
71	583	RAMCO NO 21 SPRING	S	14	EAST FORK DOLORES R	17	SENWNW	1	~~39 N~~	~~11 W~~	~~N~~	~~NS~~ D	0.0067	C	S	12/31/1972	12/31/1971	12/31/1929		44559.29219		W 803	1			
71	622	WAMBA SPRING	S	14	EAST FORK DOLORES R	17	SWNWNE	~~2~~	~~39 N~~	~~11 W~~	~~N~~	~~NS~~ D	0.0028	C	S	12/31/1972	12/31/1971	12/31/1926		44559.28123		W 797	1			
71	1911	SCOTCH CREEK	O	14	EAST FORK DOLORES R	17	SESESW	~~11~~	~~39 N~~	~~11 W~~	~~N~~	~~O~~ D	1.5000	C	S	12/31/1984	12/31/1983	07/13/1984		49137.00000		84 288	1			MIN FLOW USGS PROTRACTED LOCATION DS TERMINUS AT DOLORES RIVER
71	1907	DOLORES RIVER	O	14	EAST FORK DOLORES R	17	SENESE	~~15~~	~~39 N~~	~~11 W~~	~~N~~	~~O~~ D	20.0000	C	S	12/31/1984	12/31/1983	07/13/1984		49137.00000		84 284	1			UPPER REACH,USFS PROTRACTED LOCATION DS TERMINUS AT FILL GULCH
71	1913	WILDCAT CREEK	O	14	EAST FORK DOLORES R	42	NWNWNW	~~27~~	~~39 N~~	~~11 W~~	~~N~~	~~O~~ D	1.0000	C	S	12/31/1984	12/31/1983	07/13/1984		49137.00000		84 290	1			MIN FLOW,USGS PROTRACTED LOCATION DS TERMINUS AT DOLORES RIVER
71	613	TENDERFOOT DITCH	D	11	TENDERFOOT CREEK	42	SWNWSE	29	39 N	11 W	N	I	2.5600	C	S	03/22/1963	12/18/1933	05/01/1914		30667.23496	62-32	967	1			
71	599	SILVEY DITCH	D	14	EAST FORK DOLORES R	42	SWNENE	31	39 N	11 W	N	I	1.6000	C	S,CA	03/22/1963	12/18/1933	09/21/1950		36788.00000	62-55	W 59	1			
71	599	SILVEY DITCH	D	14	EAST FORK DOLORES R	42	SWNENE	31	39 N	11 W	N	IS	0.8000	C	S	03/22/1963	12/18/1933	09/21/1950		36788.00000	62-55	967	2			
71	599	SILVEY DITCH	D	14	EAST FORK DOLORES R	42	SWNENE	31	39 N	11 W	N	I	1.6000	C	S,C	03/22/1963	12/18/1933	09/21/1950		36788.00000	62-55	967	3			
71	1914	ROARING FORKS CREEK	O	3	ROARING FORKS CREEK	42	SWSWNE	31	39 N	11 W	N	O	2.0000	C	S	12/31/1984	12/31/1983	07/13/1984		49137.00000		84 291	1			DECREED LOC NW/4 USGS PROTRACTION AT DS TERM-DOLORES RIVER
71	557	KING NO 2 DITCH	D	2	GROUNDWATER	42	SESENW	31	39 N	11 W	N	I	1.6600	C	S	12/18/1933	02/01/1892	03/21/1890		15372.14690	D-34	967	1			
71	556	KING NO 1 DITCH	D	3	ROARING FORKS CREEK	42	SWNESE	31	39 N	11 W	N	I	4.2000	C	S	12/18/1933	02/01/1892	12/31/1891		15372.15340	D-36	967	1			
33	3523	TAYLOR RESERVOIR	R	1	LA PLATA RIVER	34	SWSENW	24	37 N	11 W	N	RP	85.5800	A	S,CA	03/21/1966	06/23/1915	10/27/1937		32076.00000	65- 3	W 1440	1			
33	3523	TAYLOR RESERVOIR	R	1	LA PLATA RIVER	34	SWSENW	24	37 N	11 W	N	IO	85.5800	A	S,C	03/21/1966	06/23/1915	10/27/1937		32076.00000	65- 3	C 807	2			
33	1903	COLUMBUS CR MIN FLOW	D	1	LA PLATA RIVER	34	SENW	25	37 N	11 W	N	O	3.0000	C	S	12/31/1976	12/31/1975	07/30/1976		46232.00000		W 1495	1			USFS QUAD LOCATION DWN ST TERMINUS
33	1904	BASIN CREEK MIN FLOW	D	1	LA PLATA RIVER	34	NESW	35	37 N	11 W	N	O	4.0000	C	S	12/31/1976	12/31/1975	07/30/1976		46232.00000		W 1497	1			USFS QUAD LOCATION DWN ST TERMINUS
33	611	GOLD KING SPRING	S	1	LA PLATA RIVER	34	NWNWNW	1	36 N	11 W	N	D	0.0111	C	S	12/31/1974	12/31/1973	07/28/1928		45290.28698		W 1246	1			SEE ALSO W 411 DENIED
33	612	GOLD KING SPRING NO 2	S	1	LA PLATA RIVER	34	NENENE	2	36 N	11 W	N	D	0.0111	C	S,C	12/31/1974	12/31/1973	07/28/1928		45290.28698		W 1247	1			SEE ALSO W 412 DENIED. DILIGENCE EXPIRED SEPT 1972
33	612	GOLD KING SPRING NO 2	S	1	LA PLATA RIVER	34	NENENE	2	36 N	11 W	N	D	0.0111	C	S,C,AB	12/31/1974	12/31/1973	07/28/1928		45290.28698		84 108	2			
33	1902	LEWIS CREEK MIN FLOW	D	1	LA PLATA RIVER	34	SWNE	3	36 N	11 W	N	O	2.0000	C	S	12/31/1976	12/31/1975	07/30/1976		46232.00000		W 1494	1			

WD	ID#	Name of Structure	Struct Type	#	Stream Name	Cty	Q-Q-Q	Sec	Ts	Rng	PM	Use Codes	Decreed Amount	U	Adj Type	Adjudicatn Date	Prev Adj Date	Approprn Date	O #	Admin Number	Priority Number	Court Case	Seq#	P A	Alter ID#	Comment
~~71~~	~~531~~	~~EAST EDER DITCH~~	~~D~~	~~13~~	~~WEST DOLORES RIVER~~	~~17~~	~~SESWNE~~	~~18~~	~~40 N~~	~~12 W~~	~~N~~	~~I~~	8.5000	C	S	03/08/1937	02/01/1892	06/01/1887		15372.13666	37-10	1528	2			
~~71~~	~~512~~	~~BRASHERS SPRING~~	~~S~~	~~14~~	~~EAST FORK DOLORES R~~	~~42~~	~~SWSENW~~	~~2~~	~~38 N~~	~~12 W~~	~~N~~	~~DS~~	0.0220	C	S	12/31/1972	12/31/1971	12/31/1971		44559.44559		W 908	1			
71	510	UNNAMED DITCH OR P-L	DL	4	PRIEST GULCH	42	SENWNE	3	38 N	12 W	N	ID	1.3020	C	S	03/22/1963	12/18/1933	07/16/1892		30667.15538	62-40B	967	1			AKA BLISS UNKNOWN DITCH AND PIPELINE
71	580	PRIEST GULCH PIPE LINE	L	4	PRIEST GULCH	42	SWNENE	3	38 N	12 W	N	RP	0.1700	C	S	03/22/1963	12/18/1933	08/08/1938		32361.00000	62-44	967	1			
71	1906	PRIEST GULCH		4	PRIEST GULCH	42	NESWNE	3	38 N	12 W	N	O	1.5000	C	S	12/31/1984	12/31/1983	07/13/1984		49137.00000		84 292	1			CWCB MIN FLOW DECREE
~~71~~	~~669~~	~~WOODY'S SPRING~~	~~S~~	~~4~~	~~PRIEST GULCH~~	~~42~~	~~NWSENE~~	~~3~~	~~38 N~~	~~12 W~~	~~N~~	~~D~~	0.0001	C	S,C	12/31/1988	12/31/1987	03/21/1988		50484.00000		88 14	1			DD APRIL 1, 1992 DECREED LOCATION SWNWNE
71	534	FRANK ROBINSON DITCH	D	14	EAST FORK DOLORES R	42	SWSESE	~~5~~	~~38 N~~	~~12~~ W	N	ID	4.1000	C	S	03/22/1963	12/18/1933	06/01/1880		30667.11110	62-4	967	1			
71	534	FRANK ROBINSON DITCH	D	14	EAST FORK DOLORES R	42	SWSESE	~~5~~	~~38 N~~	~~12 W~~	N	ID	2.3600	C	S,AB	03/22/1963	12/18/1933	06/01/1880		30667.11110	62-4	84 108	2			SEE ABANDONMENT LIST PROTEST & STIPULATION 84CW131
71	592	ROUBIDOUX DITCH	D	14	EAST FORK DOLORES R	42	NWSWSW	~~5~~	~~38 N~~	~~12 W~~	N	I	3.5000	C	S	12/18/1933	02/01/1892	08/15/1899		18124.00000	D-40	967	1			
71	592	ROUBIDOUX DITCH	D	14	EAST FORK DOLORES R	42	NWSWSW	~~5~~	~~38 N~~	~~12 W~~	N	I	0.2500	C	S,TF	12/18/1933	02/01/1892	08/15/1899		18124.00000	D-40	83 142	2			TRANS TO CHAPMAN DITCH
71	663	CHAPMAN DITCH	P	14	EAST FORK DOLORES R	42	SESWSE	~~6~~	~~38 N~~	~~12 W~~	N	I	0.2500	C	S,TT	12/18/1933	02/01/1892	08/15/1899		18124.00000	D-40	83 142	1			TRANS FROM ROUBIDOUX DITCH
71	582	QUARRY NO 1 DITCH	D	14	EAST FORK DOLORES R	42	SWSWSW	~~6~~	~~38 N~~	~~12 W~~	~~N~~	~~I~~	6.5000	C	S	12/18/1933	02/01/1892	03/21/1882		15372.11768	D-30	967	1			
71	504	BEAR CREEK DITCH	D	18	BEAR CREEK	42	SWSWNE	9	38 N	12 W	N	ID	10.6000	C	S	03/22/1963	12/18/1933	06/01/1880		30667.11110	62-5	967	1			
~~71~~	~~5048~~	~~FITZWATER WELL~~	~~W~~	~~18~~	~~BEAR CREEK~~	~~42~~	~~NWNENW~~	~~9~~	~~38 N~~	~~12 W~~	~~N~~	~~DS~~	0.0200	C	O	12/31/1981		07/31/1973		45137.00000		81 37	1			
71	1912	DOLORES RIVER	O	14	EAST FORK DOLORES R	42	NENENW	9	38 N	12 W	N	O	35.0000	C	S	12/31/1984	12/31/1983	07/13/1984		49137.00000		84 289	1			MIDDLE REACH,SUMMER,WINTER 25 CFS USGS PROT LOC DS TER AT BEAR C
71	1916	BEAR CREEK	O	18	BEAR CREEK	42	SWSENW	9	38 N	12 W	N	O	8.0000	C	S	12/31/1984	12/31/1983	07/13/1984		49137.00000		84 294	1			MIN FLOW,USGS PROTRACTED LOCATION DS TERMINUS ABOVE BEAR CR DIT.
71	618	TURKEY CREEK DITCH	D	16	LOST CANYON	42	SWSWSW	~~26~~	~~38 N~~	~~12 W~~	~~N~~	IDO	60.0000	C	S	03/22/1963	12/18/1933	03/21/1905		30667.20168	62-57	967	2			SEE ALSO ABANDONMENT PROTEST STIPULATION FOR REMOVAL OF 52 CFS
71	618	TURKEY CREEK DITCH	D	16	LOST CANYON	42	SWSWSW	~~26~~	~~38 N~~	~~12 W~~	~~N~~	~~IDO~~	40.0000	C	S	03/22/1963	12/18/1933	09/01/1946		35307.00000	62-58	967	3			ABANDONMENT LIST STIPULATION IN 84CW178
71	618	TURKEY CREEK DITCH	D	16	LOST CANYON	42	SWSWSW	~~26~~	~~38 N~~	~~12 W~~	~~N~~	~~I~~	26.5000	C	O,CA	02/01/1892		07/16/1886		13346.00000	D-17	967	5			
71	618	TURKEY CREEK DITCH	D	16	LOST CANYON	42	SWSWSW	~~26~~	~~38 N~~	~~12 W~~	~~N~~	~~I~~	26.5000	C	O,C	02/01/1892		07/16/1886		13346.00000	D-17	473	6			
71	623	WATTLES AND FREEMAN D	D	9	TURKEY CREEK	42	NENENW	~~4~~	~~37 N~~	~~12 W~~	~~N~~	~~I~~	2.5000	C	O,CA	02/01/1892		09/20/1888		14143.00000	D-18	W 294	1			

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Table 5. Household, Family, and Group Quarters Characteristics: 1990—Con.

[For definitions of terms and meanings of symbols, see text]

State County County Subdivision Place	Persons in households	All households	Family households			Nonfamily households				Persons per—		Persons in group quarters		
							Householder living alone							
								65 years and over						
			Total	Married-couple family	Female householder, no husband present	Total	Total	Total	Female	Household	Family	Total	Institutionalized persons	Other persons in group quarters
Boulder County—Con.														
Longmont division—Con.														
Niwot CDP	2 666	1 035	723	641	61	312	252	28	20	2.58	3.12	–	–	–
Upper St. Vrain division	649	291	189	169	9	102	82	30	23	2.23	2.72	–	–	–
Chaffee County	11 526	4 848	3 374	2 908	347	1 474	1 331	630	468	2.38	2.90	1 158	1 158	–
Buena Vista division	4 360	1 746	1 293	1 156	105	453	402	188	144	2.50	2.95	1 050	1 050	–
Buena Vista town	1 752	732	491	420	59	241	214	108	87	2.39	2.99	–	–	–
Salida division	7 166	3 102	2 081	1 752	242	1 021	929	442	324	2.31	2.86	108	108	–
Poncha Springs town	244	115	77	68	7	38	36	13	8	2.12	2.62	–	–	–
Salida city	4 629	2 073	1 300	1 051	188	773	713	368	277	2.23	2.87	108	108	–
Cheyenne County	2 352	904	622	561	46	282	262	112	85	2.60	3.26	45	45	–
Cheyenne Wells division	1 654	630	436	398	28	194	179	63	47	2.63	3.28	45	45	–
Cheyenne Wells town	1 083	437	280	246	25	157	144	54	44	2.48	3.23	45	45	–
Kit Carson division	698	274	186	163	18	88	83	49	38	2.55	3.22	–	–	–
Kit Carson town	305	139	78	67	9	61	58	36	28	2.19	3.04	–	–	–
Clear Creek County	7 574	3 153	2 096	1 815	195	1 057	866	148	103	2.40	2.95	45	43	2
Georgetown division	2 225	953	594	485	73	359	300	47	33	2.33	2.96	28	26	2
Empire town	401	153	97	81	10	56	49	5	4	2.62	3.41	–	–	–
Georgetown town	863	395	231	188	34	164	135	30	21	2.18	2.81	28	26	2
Silver Plume town	134	66	32	24	8	34	28	1	1	2.03	2.78	–	–	–
Idaho Springs division	5 349	2 200	1 502	1 330	122	698	566	101	70	2.43	2.95	17	17	–
Idaho Springs city	1 834	760	476	387	67	284	242	68	46	2.41	3.10	–	–	–
Conejos County	7 423	2 492	1 920	1 555	263	572	539	283	195	2.98	3.52	30	30	–
Antonito division	1 814	662	478	359	85	184	172	84	55	2.74	3.33	4	4	–
Antonito town	875	332	225	157	54	107	104	56	40	2.64	3.33	–	–	–
Conejos West division	428	155	120	105	9	35	34	19	11	2.76	3.23	–	–	–
La Jara division	3 312	1 095	847	706	101	248	233	128	92	3.02	3.57	26	26	–
La Jara town	725	266	180	140	33	86	78	36	30	2.73	3.44	–	–	–
Sanford town	750	224	176	151	19	48	47	34	26	3.35	3.95	–	–	–
Manassa division	1 869	580	475	385	68	105	100	52	37	3.22	3.68	–	–	–
Manassa town	988	308	246	205	34	62	60	31	22	3.21	3.74	–	–	–
Romeo town	341	102	86	59	18	16	14	6	5	3.34	3.70	–	–	–
Costilla County	3 188	1 192	879	680	142	313	285	136	86	2.67	3.19	2	1	1
Blanca division	1 154	432	324	257	52	108	95	44	29	2.67	3.13	–	–	–
Blanca town	272	92	75	62	10	17	16	12	11	2.96	3.33	–	–	–
San Luis division	2 034	760	555	423	90	205	190	92	57	2.68	3.23	2	1	1
San Luis town	799	296	206	141	47	90	82	43	29	2.70	3.35	1	1	–
Crowley County	2 915	1 165	816	682	105	349	314	173	119	2.50	3.06	1 031	1 031	–
Ordway division	2 503	996	696	575	94	300	274	146	105	2.51	3.09	1 031	1 031	–
Crowley town	225	79	63	48	13	16	15	10	6	2.85	3.27	–	–	–
Olney Springs town	340	131	87	67	17	44	38	19	17	2.60	3.28	–	–	–
Ordway town	970	436	278	214	49	158	150	83	61	2.22	2.85	55	55	–
Sugar City division	412	169	120	107	11	49	40	27	14	2.44	2.93	–	–	–
Sugar City town	252	110	71	61	9	39	30	22	12	2.29	2.85	–	–	–
Custer County	1 925	770	569	509	42	201	180	84	59	2.50	2.94	1	–	1
Westcliffe division	1 925	770	569	509	42	201	180	84	59	2.50	2.94	1	–	1
Silver Cliff town	322	133	83	68	13	50	42	16	10	2.42	3.04	–	–	–
Westcliffe town	312	141	85	74	4	56	55	35	28	2.21	2.96	–	–	–
Delta County	20 480	8 372	6 112	5 325	557	2 260	2 048	1 170	869	2.45	2.90	500	459	41
Cedaredge division	5 633	2 419	1 815	1 641	109	604	553	347	244	2.33	2.71	96	93	3
Cedaredge town	1 380	657	446	388	46	211	193	139	103	2.10	2.55	–	–	–
Orchard City town (pt.)	2 125	903	691	629	33	212	200	130	86	2.35	2.71	93	93	–
Delta division	8 137	3 252	2 318	1 910	300	934	840	481	389	2.50	3.00	330	310	20
Delta city	3 616	1 568	995	751	189	573	518	311	265	2.31	2.93	173	154	19
Hotchkiss division	3 749	1 514	1 119	1 007	81	395	353	184	119	2.48	2.91	12	–	12
Crawford town	221	104	63	53	5	41	39	28	19	2.13	2.76	–	–	–
Hotchkiss town	744	331	208	176	27	123	115	79	60	2.25	2.90	–	–	–
Orchard City town (pt.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Paonia division	2 961	1 187	860	767	67	327	302	158	117	2.49	2.99	62	56	6
Paonia town	1 341	562	372	324	36	190	183	102	81	2.39	3.01	62	56	6
Denver County	456 760	210 952	109 037	77 725	24 197	101 915	85 301	24 112	18 695	2.17	3.00	10 850	5 529	5 321
Denver division	456 760	210 952	109 037	77 725	24 197	101 915	85 301	24 112	18 695	2.17	3.00	10 850	5 529	5 321
Denver city	456 760	210 952	109 037	77 725	24 197	101 915	85 301	24 112	18 695	2.17	3.00	10 850	5 529	5 321
Dolores County	1 504	581	425	392	18	156	141	59	49	2.59	3.10	–	–	–
Dove Creek division	1 381	523	395	365	17	128	119	53	44	2.64	3.11	–	–	–
Dove Creek town	643	252	170	149	14	82	76	33	29	2.55	3.21	–	–	–
Rico division	123	58	30	27	1	28	22	6	5	2.12	2.97	–	–	–
Rico town	92	44	21	18	1	23	18	5	4	2.09	3.05	–	–	–
Douglas County	60 174	20 844	17 409	15 819	1 139	3 435	2 577	403	306	2.89	3.17	217	211	6
Castle Rock division	10 877	4 046	3 122	2 693	328	924	737	201	166	2.69	3.07	80	74	6
Castle Rock city (pt.)	7 103	2 697	1 965	1 622	273	732	599	167	142	2.63	3.11	35	33	2
Larkspur town	232	88	67	56	7	21	16	4	4	2.64	2.90	–	–	–
Parker division	23 215	7 783	6 720	6 108	435	1 063	766	106	78	2.98	3.21	86	86	–
Aurora city (pt.)	4	2	2	2	–	–	–	–	–	2.00	2.00	–	–	–
Castle Rock city (pt.)	1 569	537	455	402	34	82	56	3	–	2.92	3.17	–	–	–
Parker town	5 450	1 928	1 550	1 302	194	378	273	25	21	2.83	3.15	–	–	–
The Pinery CDP	4 885	1 507	1 407	1 336	54	100	76	13	9	3.24	3.36	–	–	–
Sedalia division	26 082	9 015	7 567	7 018	376	1 448	1 074	96	62	2.89	3.17	51	51	–
Castle Rock city (pt.)	1	1	–	–	–	1	1	–	–	1.00	–	–	–	–
Gateway CDP	7 459	2 476	2 148	1 971	120	328	231	17	15	3.01	3.23	51	51	–
Highlands Ranch CDP	10 181	3 510	2 865	2 643	167	645	490	21	12	2.90	3.25	–	–	–
Littleton city (pt.)	108	58	38	31	4	20	19	7	7	1.86	2.29	–	–	–
Eagle County	21 812	8 354	5 081	4 209	586	3 273	1 838	191	132	2.61	3.13	116	58	58
Basalt division	4 336	1 585	1 102	907	140	483	292	31	24	2.74	3.14	31	–	31
Basalt town (pt.)	1 002	389	250	199	38	139	80	11	9	2.58	3.00	–	–	–
El Jebel CDP	2 580	876	654	540	79	222	131	13	10	2.95	3.29	25	–	25
Eagle-Gypsum division	6 080	2 171	1 534	1 304	142	637	456	110	77	2.80	3.30	32	28	4
Eagle town	1 559	592	401	332	41	191	161	57	41	2.63	3.26	21	21	–
Gypsum town	1 750	602	458	396	45	144	103	22	16	2.91	3.32	–	–	–

Table 6. **Household, Family, and Group Quarters Characteristics: 1990**

[For definitions of terms and meanings of symbols, see text]

State County Place and [In Selected States] County Subdivision	Persons in households	All households	Family households: Total	Family households: Married-couple family	Family households: Female householder, no husband present	Nonfamily households: Total	Householder living alone: Total	Householder living alone: 65 years and over: Total	Householder living alone: 65 years and over: Female	Persons per—: Household	Persons per—: Family	Persons in group quarters: Total	Persons in group quarters: Institutionalized persons	Persons in group quarters: Other persons in group quarters
The State	**3 214 922**	**1 282 489**	**854 214**	**690 292**	**124 569**	**428 275**	**340 962**	**95 849**	**74 783**	**2.51**	**3.07**	**79 472**	**35 976**	**43 496**
COUNTY														
Adams County	262 311	96 353	69 942	54 072	11 794	26 411	20 893	5 269	4 047	2.72	3.20	2 727	1 966	761
Alamosa County	12 619	4 721	3 269	2 514	582	1 452	1 164	390	293	2.67	3.24	998	205	793
Arapahoe County	388 399	154 710	104 529	84 487	15 576	50 181	40 736	7 747	6 237	2.51	3.08	3 112	2 304	808
Archuleta County	5 345	2 010	1 547	1 323	161	463	397	125	83	2.66	3.06	–	–	–
Baca County	4 482	1 872	1 310	1 176	93	562	531	260	199	2.39	2.95	74	74	–
Bent County	4 676	1 865	1 286	1 067	162	579	534	265	189	2.51	3.09	372	353	19
Boulder County	216 699	88 402	54 375	44 957	6 955	34 027	23 245	4 960	4 057	2.45	3.01	8 640	1 350	7 290
Chaffee County	11 526	4 848	3 374	2 908	347	1 474	1 331	630	468	2.38	2.90	1 158	1 158	–
Cheyenne County	2 352	904	622	561	46	282	262	112	85	2.60	3.26	45	45	–
Clear Creek County	7 574	3 153	2 096	1 815	195	1 057	866	148	103	2.40	2.95	45	43	2
Conejos County	7 423	2 492	1 920	1 555	263	572	539	283	195	2.98	3.52	30	30	–
Costilla County	3 188	1 192	879	680	142	313	285	136	86	2.67	3.19	2	1	1
Crowley County	2 915	1 165	816	682	105	349	314	173	119	2.50	3.06	1 031	1 031	–
Custer County	1 925	770	569	509	42	201	180	84	59	2.50	2.94	1	–	1
Delta County	20 480	8 372	6 112	5 325	557	2 260	2 048	1 170	869	2.45	2.90	500	459	41
Denver County	456 760	210 952	109 037	77 725	24 197	101 915	85 301	24 112	18 695	2.17	3.00	10 850	5 529	5 321
Dolores County	1 504	581	425	392	18	156	141	59	49	2.59	3.10	–	–	–
Douglas County	60 174	20 844	17 409	15 819	1 139	3 435	2 577	403	306	2.89	3.17	217	211	6
Eagle County	21 812	8 354	5 081	4 209	586	3 273	1 838	191	132	2.61	3.13	116	58	58
Elbert County	9 601	3 377	2 763	2 492	164	614	496	189	136	2.84	3.16	45	45	–
El Paso County	381 460	146 965	104 095	85 618	14 398	42 870	34 821	8 761	6 990	2.60	3.10	15 554	2 599	12 955
Fremont County	28 370	11 713	8 287	6 914	1 114	3 426	3 097	1 683	1 295	2.42	2.92	3 903	3 719	184
Garfield County	29 283	11 266	7 966	6 727	859	3 300	2 510	842	633	2.60	3.07	691	457	234
Gilpin County	3 068	1 308	848	731	71	460	356	78	46	2.35	2.86	2	2	–
Grand County	7 891	3 168	2 050	1 791	160	1 118	758	178	118	2.49	2.99	75	25	50
Gunnison County	9 186	3 855	2 218	1 895	221	1 637	1 033	184	129	2.38	2.96	1 087	53	1 034
Hinsdale County	467	214	135	126	6	79	61	16	7	2.18	2.69	–	–	–
Huerfano County	5 893	2 446	1 649	1 315	273	797	738	419	303	2.41	3.01	116	111	5
Jackson County	1 594	632	454	404	29	178	158	42	28	2.52	3.00	11	1	10
Jefferson County	431 948	166 545	119 462	99 161	15 277	47 083	36 851	8 471	6 813	2.59	3.06	6 482	5 374	1 108
Kiowa County	1 644	657	473	423	36	184	177	101	75	2.50	3.07	44	30	14
Kit Carson County	7 074	2 785	2 008	1 776	173	777	716	350	276	2.54	3.07	66	66	–
Lake County	5 983	2 382	1 562	1 293	199	820	656	171	112	2.51	3.13	24	19	5
La Plata County	30 618	11 976	8 008	6 555	1 058	3 968	2 829	871	686	2.56	3.06	1 666	235	1 431
Larimer County	179 612	70 472	47 247	40 099	5 386	23 225	16 178	4 633	3 801	2.55	3.05	6 524	1 405	5 119
Las Animas County	13 383	5 421	3 694	2 837	663	1 727	1 586	823	604	2.47	3.07	382	221	161
Lincoln County	4 424	1 817	1 249	1 093	116	568	518	284	199	2.43	3.01	105	81	24
Logan County	17 180	6 978	4 791	4 099	514	2 187	1 919	893	707	2.46	3.02	387	260	127
Mesa County	90 797	36 250	25 419	20 830	3 557	10 831	8 973	3 663	2 811	2.50	3.00	2 348	1 129	1 219
Mineral County	558	247	159	141	14	88	75	30	21	2.26	2.81	–	–	–
Moffat County	11 228	4 178	3 061	2 635	310	1 117	980	317	249	2.69	3.20	129	129	–
Montezuma County	18 520	6 762	5 139	4 200	705	1 623	1 453	649	511	2.74	3.20	152	139	13
Montrose County	24 028	9 405	6 973	5 972	758	2 432	2 118	1 034	784	2.55	3.00	395	342	53
Morgan County	21 483	8 139	5 890	4 951	642	2 249	2 006	996	769	2.64	3.15	456	409	47
Otero County	19 692	7 593	5 448	4 331	892	2 145	1 949	1 030	795	2.59	3.13	493	354	139
Ouray County	2 292	947	677	606	49	270	230	89	61	2.42	2.88	3	–	3
Park County	7 174	2 775	2 071	1 900	111	704	553	103	59	2.59	3.00	–	–	–
Phillips County	4 124	1 712	1 182	1 037	112	530	494	282	211	2.41	2.97	65	65	–
Pitkin County	12 541	5 877	2 687	2 222	317	3 190	2 081	126	80	2.13	2.79	120	22	98
Prowers County	13 161	4 984	3 564	2 908	526	1 420	1 283	615	488	2.64	3.21	186	69	117
Pueblo County	120 136	47 057	33 248	25 244	6 451	13 809	12 162	5 388	4 111	2.55	3.08	2 915	2 077	838
Rio Blanco County	5 819	2 181	1 609	1 421	128	572	482	197	147	2.67	3.15	153	47	106
Rio Grande County	10 572	3 930	2 979	2 422	426	951	858	398	289	2.69	3.14	198	198	–
Routt County	13 923	5 483	3 451	2 916	354	2 032	1 279	219	155	2.54	3.06	165	61	104
Saguache County	4 529	1 643	1 214	980	181	429	385	168	112	2.76	3.27	90	8	82
San Juan County	745	287	199	159	22	88	75	10	2	2.60	3.17	–	–	–
San Miguel County	3 597	1 489	846	713	95	643	394	49	32	2.42	2.94	56	–	56
Sedgwick County	2 658	1 141	795	704	59	346	327	178	136	2.33	2.86	32	32	–
Summit County	12 826	5 295	2 847	2 464	243	2 448	1 254	62	36	2.42	2.92	55	17	38
Teller County	12 404	4 720	3 602	3 185	311	1 118	912	215	157	2.63	3.03	64	51	13
Washington County	4 778	1 915	1 374	1 229	92	541	500	267	206	2.50	3.02	34	34	–
Weld County	127 661	47 470	33 763	27 792	4 343	13 707	10 564	3 767	2 954	2.69	3.19	4 160	1 162	2 998
Yuma County	8 833	3 472	2 460	2 205	194	1 012	935	491	378	2.54	3.11	121	111	10
PLACE AND COUNTY SUBDIVISION														
Aguilar town, Las Animas County	520	215	142	106	28	73	65	47	34	2.42	3.03	–	–	–
Air Force Academy CDP, El Paso County	4 387	1 205	1 176	1 112	44	29	28	–	–	3.64	3.70	4 675	–	4 675
Akron town, Washington County	1 565	697	439	369	53	258	242	153	128	2.25	2.90	34	34	–
Alamosa city, Alamosa County	6 615	2 661	1 690	1 198	389	971	775	273	218	2.49	3.13	964	171	793
Alamosa East CDP, Alamosa County	1 389	488	359	275	69	129	103	33	24	2.85	3.33	–	–	–
Alma town, Park County	148	72	38	32	3	34	25	4	3	2.06	2.66	–	–	–
Antonito town, Conejos County	875	332	225	157	54	107	104	56	40	2.64	3.33	–	–	–
Applewood CDP, Jefferson County	10 921	4 414	3 185	2 610	430	1 229	1 009	376	297	2.47	2.90	148	148	–
Arriba town, Lincoln County	220	101	56	49	5	45	42	25	15	2.18	3.05	–	–	–
Arvada city	88 677	32 744	24 710	20 429	3 243	8 034	6 382	1 705	1 425	2.71	3.13	558	509	49
Adams County	2 347	846	645	539	75	201	153	16	13	2.77	3.16	–	–	–
Jefferson County	86 330	31 898	24 065	19 890	3 168	7 833	6 229	1 689	1 412	2.71	3.13	558	509	49
Aspen city, Pitkin County	4 958	2 551	863	682	127	1 688	1 106	61	39	1.94	2.68	91	22	69
Ault town, Weld County	1 107	439	307	242	49	132	119	73	57	2.52	3.05	–	–	–
Aurora city	219 814	89 132	58 034	44 525	10 554	31 098	25 069	4 278	3 391	2.47	3.07	2 289	954	1 335
Adams County	26 950	10 592	7 054	4 895	1 696	3 538	2 926	653	485	2.54	3.12	797	168	629
Arapahoe County	192 860	78 538	50 978	39 628	8 858	27 560	22 143	3 625	2 906	2.46	3.06	1 492	786	706
Douglas County	4	2	2	2	–	–	–	–	–	2.00	2.00	–	–	–
Avon town, Eagle County	1 798	707	338	270	47	369	138	6	1	2.54	3.11	–	–	–
Basalt town	1 128	443	289	232	42	154	91	11	9	2.55	2.94	–	–	–
Eagle County	1 002	389	250	199	38	139	80	11	9	2.58	3.00	–	–	–
Pitkin County	126	54	39	33	4	15	11	–	–	2.33	2.62	–	–	–
Battlement Mesa CDP, Garfield County	1 477	673	494	458	26	179	158	87	43	2.19	2.57	–	–	–
Bayfield town, La Plata County	1 090	371	286	240	29	85	69	32	21	2.94	3.39	–	–	–
Bennett town, Adams County	1 757	581	465	386	57	116	104	39	33	3.02	3.43	–	–	–
Berthoud town, Larimer County	2 938	1 102	815	666	111	287	248	115	91	2.67	3.15	52	52	–
Bethune town, Kit Carson County	173	58	47	44	3	11	10	2	1	2.98	3.43	–	–	–
Black Forest CDP, El Paso County	8 135	2 725	2 339	2 169	116	386	293	61	48	2.99	3.22	8	–	8

Table 6. **Household, Family, and Group Quarters Characteristics: 1990**—Con.

[For definitions of terms and meanings of symbols, see text]

State County Place and [In Selected States] County Subdivision	Persons in households	All households	Family households: Total	Family households: Married-couple family	Family households: Female householder, no husband present	Nonfamily households: Total	Nonfamily households: Householder living alone: Total	Householder living alone: 65 years and over: Total	Householder living alone: 65 years and over: Female	Persons per—: Household	Persons per—: Family	Persons in group quarters: Total	Persons in group quarters: Institutionalized persons	Persons in group quarters: Other persons in group quarters
PLACE AND COUNTY SUBDIVISION—Con.														
Marble town, Gunnison County	63	26	16	14	1	10	9	3	1	2.42	3.00	1	–	1
Mead town, Weld County	456	147	127	105	12	20	18	6	4	3.10	3.39	–	–	–
Meeker town, Rio Blanco County	2 059	820	557	468	57	263	243	123	100	2.51	3.15	39	39	–
Merino town, Logan County	238	94	64	56	6	30	27	14	12	2.53	3.19	–	–	–
Milliken town, Weld County	1 605	468	397	306	77	71	64	34	23	3.43	3.73	–	–	–
Minturn town, Eagle County	1 055	389	256	213	29	133	79	10	8	2.71	3.27	11	–	11
Moffat town, Saguache County	99	48	22	18	3	26	25	12	9	2.06	3.27	–	–	–
Monte Vista city, Rio Grande County	4 278	1 572	1 165	857	251	407	369	188	139	2.72	3.21	46	46	–
Montezuma town, Summit County	60	31	9	9	–	22	14	–	–	1.94	2.78	–	–	–
Montrose city, Montrose County	8 535	3 671	2 437	1 937	403	1 234	1 085	550	429	2.32	2.87	319	284	35
Monument town, El Paso County	1 020	378	283	220	48	95	77	17	16	2.70	3.13	–	–	–
Morrison town, Jefferson County	302	139	74	65	5	65	47	15	9	2.17	2.80	163	163	–
Mountain View town, Jefferson County	550	262	143	100	37	119	93	37	33	2.10	2.72	–	–	–
Mount Crested Butte town, Gunnison County	264	129	48	41	5	81	43	4	2	2.05	2.69	–	–	–
Naturita town, Montrose County	434	180	131	116	12	49	41	18	13	2.41	2.85	–	–	–
Nederland town, Boulder County	1 099	463	268	197	57	195	137	16	13	2.37	2.98	–	–	–
New Castle town, Garfield County	679	266	184	153	17	82	61	25	17	2.55	3.05	–	–	–
Niwot CDP, Boulder County	2 666	1 035	723	641	61	312	252	28	20	2.58	3.12	–	–	–
Northglenn city	27 034	9 829	7 310	5 850	1 074	2 519	1 998	437	331	2.75	3.19	161	161	–
Adams County	27 034	9 829	7 310	5 850	1 074	2 519	1 998	437	331	2.75	3.19	161	161	–
Weld County	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Norwood town, San Miguel County	429	170	119	101	14	51	43	15	10	2.52	3.04	–	–	–
Nucla town, Montrose County	656	275	187	159	20	88	82	45	38	2.39	2.95	–	–	–
Nunn town, Weld County	324	117	87	74	7	30	26	10	5	2.77	3.22	–	–	–
Oak Creek town, Routt County	673	301	182	136	36	119	106	39	25	2.24	2.91	–	–	–
Olathe town, Montrose County	1 188	454	324	260	54	130	118	75	57	2.62	3.13	75	58	17
Olney Springs town, Crowley County	340	131	87	67	17	44	38	19	17	2.60	3.28	–	–	–
Ophir town, San Miguel County	69	33	14	14	–	19	7	–	–	2.09	2.57	–	–	–
Orchard City town, Delta County	2 125	903	691	629	33	212	200	130	86	2.35	2.71	93	93	–
Orchard Mesa CDP, Mesa County	5 977	2 141	1 722	1 501	160	419	337	132	95	2.79	3.13	–	–	–
Ordway town, Crowley County	970	436	278	214	49	158	150	83	61	2.22	2.85	55	55	–
Otis town, Washington County	451	198	125	109	10	73	68	39	32	2.28	2.96	–	–	–
Ouray city, Ouray County	643	290	179	157	16	111	100	39	27	2.22	2.88	1	–	1
Ovid town, Sedgwick County	349	147	104	92	10	43	39	29	23	2.37	2.88	–	–	–
Pagosa Springs town, Archuleta County	1 207	451	330	235	74	121	110	51	35	2.68	3.18	–	–	–
Palisade town, Mesa County	1 781	759	508	381	99	251	226	110	82	2.35	2.91	90	79	11
Palmer Lake town, El Paso County	1 480	562	398	337	44	164	126	38	26	2.63	3.16	–	–	–
Paoli town, Phillips County	29	15	11	10	1	4	4	4	3	1.93	2.27	–	–	–
Paonia town, Delta County	1 341	562	372	324	36	190	183	102	81	2.39	3.01	62	56	6
Parachute town, Garfield County	658	262	184	155	19	78	68	34	26	2.51	3.02	–	–	–
Parker town, Douglas County	5 450	1 928	1 550	1 302	194	378	273	25	21	2.83	3.15	–	–	–
Peetz town, Logan County	179	75	48	40	7	27	26	15	9	2.39	3.10	–	–	–
Penrose CDP, Fremont County	2 231	785	636	554	54	149	123	50	32	2.84	3.18	4	4	–
Pierce town, Weld County	823	261	227	193	23	34	31	13	11	3.15	3.43	–	–	–
Pitkin town, Gunnison County	53	26	18	16	2	8	6	2	–	2.04	2.39	–	–	–
Platteville town, Weld County	1 515	522	415	331	58	107	96	43	26	2.90	3.31	–	–	–
Poncha Springs town, Chaffee County	244	115	77	68	7	38	36	13	8	2.12	2.62	–	–	–
Ponderosa Park CDP, Elbert County	1 640	531	471	422	28	60	39	8	4	3.09	3.27	–	–	–
Pritchett town, Baca County	153	67	44	37	4	23	22	13	12	2.28	2.93	–	–	–
Prospect Heights town, Fremont County	19	9	5	4	1	4	4	3	3	2.11	3.00	–	–	–
Pueblo city, Pueblo County	95 855	38 324	26 225	19 221	5 714	12 099	10 693	4 830	3 710	2.50	3.07	2 785	2 038	747
Pueblo West CDP, Pueblo County	4 373	1 619	1 312	1 170	111	307	245	57	41	2.70	2.96	13	–	13
Ramah town, El Paso County	94	40	26	22	3	14	10	5	1	2.35	2.88	–	–	–
Rangely town, Rio Blanco County	2 164	783	572	499	53	211	158	39	29	2.76	3.25	114	8	106
Raymer town, Weld County	98	39	28	24	4	11	9	2	1	2.51	3.04	–	–	–
Red Cliff town, Eagle County	291	91	75	60	12	16	8	2	2	3.20	3.48	6	–	6
Redlands CDP, Mesa County	9 353	3 527	2 885	2 628	188	642	547	203	159	2.65	2.95	2	–	2
Rico town, Dolores County	92	44	21	18	1	23	18	5	4	2.09	3.05	–	–	–
Ridgway town, Ouray County	421	161	115	95	16	46	36	11	8	2.61	3.10	2	–	2
Rifle city, Garfield County	4 636	1 815	1 251	1 020	164	564	470	194	157	2.55	3.11	–	–	–
Rockvale town, Fremont County	321	137	85	67	14	52	46	29	25	2.34	3.02	–	–	–
Rocky Ford city, Otero County	4 070	1 579	1 089	802	245	490	449	244	185	2.58	3.16	92	92	–
Romeo town, Conejos County	341	102	86	59	18	16	14	6	5	3.34	3.70	–	–	–
Rye town, Pueblo County	168	69	47	38	8	22	20	8	7	2.43	3.04	–	–	–
Saguache town, Saguache County	576	247	168	132	29	79	75	35	23	2.33	2.90	8	8	–
Salida city, Chaffee County	4 629	2 073	1 300	1 051	188	773	713	368	277	2.23	2.87	108	108	–
Sanford town, Conejos County	750	224	176	151	19	48	47	34	26	3.35	3.95	–	–	–
San Luis town, Costilla County	799	296	206	141	47	90	82	43	29	2.70	3.35	1	1	–
Sawpit town, San Miguel County	36	14	7	6	1	7	2	–	–	2.57	3.29	–	–	–
Security-Widefield CDP, El Paso County	23 809	7 828	6 707	5 619	840	1 121	897	244	203	3.04	3.28	13	–	13
Sedgwick town, Sedgwick County	183	85	58	51	6	27	25	12	6	2.15	2.66	–	–	–
Seibert town, Kit Carson County	181	85	54	50	3	31	30	20	17	2.13	2.72	–	–	–
Severance town, Weld County	106	41	26	16	6	15	12	7	7	2.59	3.19	–	–	–
Sheridan city, Arapahoe County	4 955	1 982	1 308	900	317	674	577	232	186	2.50	3.08	21	10	11
Sheridan Lake town, Kiowa County	95	34	27	23	1	7	7	2	2	2.79	3.26	–	–	–
Sherrelwood CDP, Adams County	16 636	5 894	4 453	3 438	714	1 441	1 053	183	136	2.82	3.22	–	–	–
Silt town, Garfield County	1 095	439	306	250	44	133	113	45	39	2.49	3.01	–	–	–
Silver Cliff town, Custer County	322	133	83	68	13	50	42	16	10	2.42	3.04	–	–	–
Silver Plume town, Clear Creek County	134	66	32	24	8	34	28	1	1	2.03	2.78	–	–	–
Silverthorne town, Summit County	1 767	697	396	334	38	301	149	8	4	2.54	3.09	1	–	1
Silverton town, San Juan County	716	275	191	153	22	84	72	9	2	2.60	3.18	–	–	–
Simla town, Elbert County	454	183	126	106	18	57	56	31	24	2.48	3.13	27	27	–
Snowmass Village town, Pitkin County	1 437	684	329	285	29	355	219	10	8	2.10	2.64	12	–	12
Southglenn CDP, Arapahoe County	42 988	15 218	12 399	10 730	1 364	2 819	2 299	473	406	2.82	3.15	99	99	–
Springfield town, Baca County	1 416	654	410	345	47	244	232	126	103	2.17	2.80	59	59	–
Starkville town, Las Animas County	104	39	33	23	8	6	6	6	5	2.67	2.97	–	–	–
Steamboat Springs city, Routt County	6 530	2 702	1 473	1 167	206	1 229	687	86	61	2.42	2.98	165	61	104
Sterling city, Logan County	10 012	4 317	2 675	2 155	407	1 642	1 431	671	551	2.32	2.99	350	225	125
Stratmoor CDP, El Paso County	5 854	1 935	1 587	1 247	269	348	263	69	55	3.03	3.31	–	–	–
Stratton town, Kit Carson County	649	278	190	160	28	88	84	43	28	2.33	2.89	–	–	–
Sugar City town, Crowley County	252	110	71	61	9	39	30	22	12	2.29	2.85	–	–	–
Superior town	255	101	60	47	7	41	31	12	9	2.52	3.28	–	–	–
Boulder County	255	101	60	47	7	41	31	12	9	2.52	3.28	–	–	–
Jefferson County	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 15. **Land Area and Population Density: 1990**

[For definitions of terms and meanings of symbols, see text]

State / County / County Subdivision / Place	All persons	Land area		Persons per—	
		Square kilometers	Square miles	Square kilometer	Square mile
The State	**3 294 394**	**268 659.5**	**103 729.5**	**12.3**	**31.8**
Adams County	265 038	3 087.3	1 192.0	85.8	222.3
Brighton division	20 157	383.6	148.1	52.5	136.1
Brighton city (pt.)	14 186	37.8	14.6	375.3	971.6
Broomfield city (pt.)	38	15.5	6.0	2.5	6.3
Commerce City city (pt.)	210	26.5	10.2	7.9	20.6
Thornton city (pt.)	14	2.8	1.1	5.0	12.7
Westminster city (pt.)	-	1.1	.4	-	-
Commerce City division	23 311	114.6	44.3	203.4	526.2
Commerce City city (pt.)	16 256	25.2	9.7	645.1	1 675.9
Derby CDP	6 043	4.6	1.8	1 313.7	3 357.2
Thornton city (pt.)	-	1.9	.7	-	-
East Adams division	4 053	2 254.1	870.3	1.8	4.7
Aurora city (pt.)	224	42.1	16.3	5.3	13.7
Bennett town	1 757	4.2	1.6	418.3	1 098.1
North Aurora division	27 639	142.0	54.8	194.6	504.4
Aurora city (pt.)	27 523	96.5	37.2	285.2	739.9
West Adams division	189 878	193.0	74.5	983.8	2 548.7
Arvada city (pt.)	2 347	1.3	.5	1 805.4	4 694.0
Brighton city (pt.)	-	-	-	-	-
Broomfield city (pt.)	6 684	10.5	4.0	636.6	1 671.0
Federal Heights city	9 342	4.7	1.8	1 987.7	5 190.0
Northglenn city (pt.)	27 195	16.5	6.4	1 648.2	4 249.2
Sherrelwood CDP	16 636	6.4	2.5	2 599.4	6 654.4
Thornton city (pt.)	55 017	48.8	18.8	1 127.4	2 926.4
Welby CDP	10 218	9.9	3.8	1 032.1	2 688.9
Westminster city (pt.)	41 639	38.7	15.0	1 075.9	2 775.9
Westminster East CDP	5 197	4.3	1.7	1 208.6	3 057.1
Alamosa County	13 617	1 872.1	722.8	7.3	18.8
Alamosa division	12 580	808.2	312.0	15.6	40.3
Alamosa city	7 579	9.0	3.5	842.1	2 165.4
Alamosa East CDP	1 389	9.7	3.8	143.2	365.5
Mosca-Hooper division	1 037	1 063.9	410.8	1.0	2.5
Hooper town	112	.6	.3	186.7	373.3
Arapahoe County	391 511	2 080.2	803.2	188.2	487.4
East Arapahoe division	4 939	1 697.6	655.4	2.9	7.5
Aurora city (pt.)	144	83.5	32.2	1.7	4.5
Byers CDP	1 065	11.1	4.3	95.9	247.7
Deer Trail town	476	2.4	.9	198.3	528.9
South Aurora division	223 670	203.0	78.4	1 101.8	2 852.9
Aurora city (pt.)	194 208	118.2	45.6	1 643.0	4 258.9
Glendale city	2 453	1.4	.5	1 752.1	4 906.0
Southwest Arapahoe division	162 902	179.7	69.4	906.5	2 347.3
Aurora city (pt.)	-	1.1	.4	-	-
Bow Mar town (pt.)	613	1.1	.4	557.3	1 532.5
Castlewood CDP	24 392	16.2	6.3	1 505.7	3 871.7
Cherry Hills Village city	5 245	16.1	6.2	325.8	846.0
Columbine CDP (pt.)	1 572	1.9	.7	827.4	2 245.7
Columbine Valley town	1 071	2.5	1.0	428.4	1 071.0
Englewood city	29 387	16.9	6.5	1 738.9	4 521.1
Greenwood Village city	7 589	20.0	7.7	379.5	985.6
Littleton city (pt.)	33 577	31.4	12.1	1 069.3	2 775.0
Sheridan city	4 976	5.7	2.2	873.0	2 261.8
Southglenn CDP	43 087	25.5	9.9	1 689.7	4 352.2
Archuleta County	5 345	3 494.9	1 349.4	1.5	4.0
Arboles division	587	1 251.2	483.1	.5	1.2
Pagosa Springs division	4 758	2 243.8	866.3	2.1	5.5
Pagosa Springs town	1 207	6.0	2.3	201.2	524.8
Baca County	4 556	6 619.7	2 555.9	.7	1.8
Campo division	487	1 236.3	477.3	.4	1.0
Campo town	121	.4	.1	302.5	1 210.0
Pritchett division	383	1 806.4	697.4	.2	.5
Pritchett town	153	.6	.2	255.0	765.0
Springfield division	2 137	1 302.9	503.0	1.6	4.2
Springfield town	1 475	2.1	.8	702.4	1 843.8
Vilas town	105	.3	.1	350.0	1 050.0
Walsh division	1 549	2 274.1	878.0	.7	1.8
Two Buttes town	63	.6	.2	105.0	315.0
Walsh town	692	1.2	.5	576.7	1 384.0
Bent County	5 048	3 921.3	1 514.0	1.3	3.3
Las Animas division	3 986	544.0	210.0	7.3	19.0
Las Animas city	2 481	3.3	1.3	751.8	1 908.5
McClave division	813	682.6	263.5	1.2	3.1
Purgatoire Valley division	249	2 694.8	1 040.4	.1	.2
Boulder County	225 339	1 923.0	742.5	117.2	303.5
Bald Mountain division	9 566	591.7	228.5	16.2	41.9
Boulder city (pt.)	20	2.3	.9	8.7	22.2
Jamestown town	251	1.7	.7	147.6	358.6
Nederland town	1 099	3.6	1.4	305.3	785.0
Ward town	159	1.5	.6	106.0	265.0
Boulder division	103 653	267.4	103.3	387.6	1 003.4
Boulder city (pt.)	83 292	56.1	21.7	1 484.7	3 838.3
Gunbarrel CDP (pt.)	8 350	15.3	5.9	545.8	1 415.3
Louisville city (pt.)	131	2.2	.9	59.5	145.6
Superior town (pt.)	242	1.5	.6	161.3	403.3
Lafayette-Louisville division	47 779	149.8	57.8	319.0	826.6
Broomfield city (pt.)	16 390	21.5	8.3	762.3	1 974.7
Erie town (pt.)	14	3.3	1.3	4.2	10.8
Lafayette city	14 548	17.9	6.9	812.7	2 108.4
Louisville city (pt.)	12 230	17.6	6.8	694.9	1 798.5
Superior town (pt.)	13	6.7	2.6	1.9	5.0
Longmont division	63 692	416.9	161.0	152.8	395.6
Boulder city (pt.)	-	-	-	-	-
Gunbarrel CDP (pt.)	1 038	.6	.2	1 730.0	5 190.0
Longmont city	51 555	34.0	13.1	1 516.3	3 935.5
Lyons town	1 227	2.5	1.0	490.8	1 227.0
Niwot CDP	2 666	10.5	4.1	253.9	650.2
Upper St. Vrain division	649	497.2	192.0	1.3	3.4
Chaffee County	12 684	2 625.0	1 013.5	4.8	12.5
Buena Vista division	5 410	1 413.3	545.7	3.8	9.9
Buena Vista town	1 752	8.7	3.4	201.4	515.3
Salida division	7 274	1 211.8	467.9	6.0	15.5
Poncha Springs town	244	2.9	1.1	84.1	221.8
Salida city	4 737	5.7	2.2	831.1	2 153.2
Cheyenne County	2 397	4 614.0	1 781.5	.5	1.3
Cheyenne Wells division	1 699	2 063.0	796.5	.8	2.1
Cheyenne Wells town	1 128	2.7	1.0	417.8	1 128.0
Kit Carson division	698	2 551.0	985.0	.3	.7
Kit Carson town	305	1.4	.6	217.9	508.3
Clear Creek County	7 619	1 024.2	395.5	7.4	19.3
Georgetown division	2 253	523.2	202.0	4.3	11.2
Empire town	401	.7	.3	572.9	1 336.7
Georgetown town	891	1.9	.7	468.9	1 272.9
Silver Plume town	134	.6	.2	223.3	670.0
Idaho Springs division	5 366	501.0	193.4	10.7	27.7
Idaho Springs city	1 834	2.1	.8	873.3	2 292.5
Conejos County	7 453	3 334.2	1 287.3	2.2	5.8
Antonito division	1 818	492.4	190.1	3.7	9.6
Antonito town	875	1.0	.4	875.0	2 187.5
Conejos West division	428	2 106.7	813.4	.2	.5
La Jara division	3 338	610.0	235.5	5.5	14.2
La Jara town	725	.8	.3	906.3	2 416.7
Sanford town	750	3.6	1.4	208.3	535.7
Manassa division	1 869	125.1	48.3	14.9	38.7
Manassa town	988	2.4	.9	411.7	1 097.8
Romeo town	341	.6	.2	568.3	1 705.0
Costilla County	3 190	3 178.5	1 227.2	1.0	2.6
Blanca division	1 154	1 358.8	524.6	.8	2.2
Blanca town	272	4.6	1.8	59.1	151.1
San Luis division	2 036	1 819.7	702.6	1.1	2.9
San Luis town	800	1.2	.5	666.7	1 600.0
Crowley County	3 946	2 043.6	789.0	1.9	5.0
Ordway division	3 534	1 261.9	487.2	2.8	7.3
Crowley town	225	.7	.3	321.4	750.0
Olney Springs town	340	.6	.2	566.7	1 700.0
Ordway town	1 025	2.0	.8	512.5	1 281.3
Sugar City division	412	781.7	301.8	.5	1.4
Sugar City town	252	1.0	.4	252.0	630.0
Custer County	1 926	1 913.8	738.9	1.0	2.6
Westcliffe division	1 926	1 913.8	738.9	1.0	2.6
Silver Cliff town	322	40.5	15.6	8.0	20.6
Westcliffe town	312	2.9	1.1	107.6	283.6
Delta County	20 980	2 958.3	1 142.2	7.1	18.4
Cedaredge division	5 729	708.7	273.6	8.1	20.9
Cedaredge town	1 380	3.3	1.3	418.2	1 061.5
Orchard City town (pt.)	2 218	29.5	11.4	75.2	194.6
Delta division	8 467	828.9	320.0	10.2	26.5
Delta city	3 789	7.1	2.8	533.7	1 353.2
Hotchkiss division	3 761	813.7	314.2	4.6	12.0
Crawford town	221	.6	.2	368.3	1 105.0
Hotchkiss town	744	1.7	.7	437.6	1 062.9
Orchard City town (pt.)	-	-	-	-	-
Paonia division	3 023	607.0	234.4	5.0	12.9
Paonia town	1 403	2.0	.8	701.5	1 753.8
Denver County	467 610	397.0	153.3	1 177.9	3 050.3
Denver division	467 610	397.0	153.3	1 177.9	3 050.3
Denver city	467 610	397.0	153.3	1 177.9	3 050.3
Dolores County	1 504	2 763.6	1 067.0	.5	1.4
Dove Creek division	1 381	773.5	298.7	1.8	4.6
Dove Creek town	643	1.4	.5	459.3	1 286.0
Rico division	123	1 990.0	768.4	.1	.2
Rico town	92	2.0	.8	46.0	115.0
Douglas County	60 391	2 176.0	840.2	27.8	71.9
Castle Rock division	10 957	675.3	260.7	16.2	42.0
Castle Rock city (pt.)	7 138	50.4	19.5	141.6	366.1
Larkspur town	232	11.5	4.4	20.2	52.7
Parker division	23 301	643.6	248.5	36.2	93.8
Aurora city (pt.)	4	2.0	.8	2.0	5.0
Castle Rock city (pt.)	1 569	27.4	10.6	57.3	148.0
Parker town	5 450	34.3	13.2	158.9	412.9
The Pinery CDP	4 885	14.2	5.5	344.0	888.2
Sedalia division	26 133	857.1	330.9	30.5	79.0
Castle Rock city (pt.)	1	2.1	.8	.5	1.3
Gateway CDP	7 510	13.8	5.3	544.2	1 417.0
Highlands Ranch CDP	10 181	12.5	4.8	814.5	2 121.0
Littleton city (pt.)	108	.5	.2	216.0	540.0
Eagle County	21 928	4 371.8	1 688.0	5.0	13.0
Basalt division	4 367	495.0	191.1	8.8	22.9
Basalt town (pt.)	1 002	1.2	.4	835.0	2 505.0
El Jebel CDP	2 605	14.9	5.7	174.8	457.0
Eagle-Gypsum division	6 112	2 562.9	989.5	2.4	6.2
Eagle town	1 580	2.3	.9	687.0	1 755.6
Gypsum town	1 750	4.9	1.9	357.1	921.1
Minturn-Red Cliff division	11 449	1 313.9	507.3	8.7	22.6
Avon town	1 798	13.1	5.0	137.3	359.6
Eagle-Vail CDP	1 922	1.7	.6	1 130.6	3 203.3
Minturn town	1 066	3.6	1.4	296.1	761.4
Red Cliff town	297	.6	.2	495.0	1 485.0
Vail town	3 659	12.1	4.7	302.4	778.5

Table 16. **Land Area and Population Density: 1990**

[For definitions of terms and meanings of symbols, see text]

State County Place and [In Selected States] County Subdivision	All persons	Land area: Square kilometers	Land area: Square miles	Persons per—: Square kilometer	Persons per—: Square mile
The State	**3 294 394**	**268 659.5**	**103 729.5**	**12.3**	**31.8**
COUNTY					
Adams County	265 038	3 087.3	1 192.0	85.8	222.3
Alamosa County	13 617	1 872.1	722.8	7.3	18.8
Arapahoe County	391 511	2 080.2	803.2	188.2	487.4
Archuleta County	5 345	3 494.9	1 349.4	1.5	4.0
Baca County	4 556	6 619.7	2 555.9	.7	1.8
Bent County	5 048	3 921.3	1 514.0	1.3	3.3
Boulder County	225 339	1 923.0	742.5	117.2	303.5
Chaffee County	12 684	2 625.0	1 013.5	4.8	12.5
Cheyenne County	2 397	4 614.0	1 781.5	.5	1.3
Clear Creek County	7 619	1 024.2	395.5	7.4	19.3
Conejos County	7 453	3 334.2	1 287.3	2.2	5.8
Costilla County	3 190	3 178.5	1 227.2	1.0	2.6
Crowley County	3 946	2 043.6	789.0	1.9	5.0
Custer County	1 926	1 913.8	738.9	1.0	2.6
Delta County	20 980	2 958.3	1 142.2	7.1	18.4
Denver County	467 610	397.0	153.3	1 177.9	3 050.3
Dolores County	1 504	2 763.6	1 067.0	.5	1.4
Douglas County	60 391	2 176.0	840.2	27.8	71.9
Eagle County	21 928	4 371.8	1 688.0	5.0	13.0
Elbert County	9 646	4 793.8	1 850.9	2.0	5.2
El Paso County	397 014	5 508.1	2 126.7	72.1	186.7
Fremont County	32 273	3 970.6	1 533.0	8.1	21.1
Garfield County	29 974	7 634.0	2 947.5	3.9	10.2
Gilpin County	3 070	388.2	149.9	7.9	20.5
Grand County	7 966	4 790.9	1 849.8	1.7	4.3
Gunnison County	10 273	8 389.0	3 239.0	1.2	3.2
Hinsdale County	467	2 895.0	1 117.8	.2	.4
Huerfano County	6 009	4 120.7	1 591.0	1.5	3.8
Jackson County	1 605	4 178.5	1 613.3	.4	1.0
Jefferson County	438 430	2 000.1	772.2	219.2	567.8
Kiowa County	1 688	4 587.2	1 771.1	.4	1.0
Kit Carson County	7 140	5 597.0	2 161.0	1.3	3.3
Lake County	6 007	976.2	376.9	6.2	15.9
La Plata County	32 284	4 383.0	1 692.3	7.4	19.1
Larimer County	186 136	6 737.7	2 601.4	27.6	71.6
Las Animas County	13 765	12 362.0	4 773.0	1.1	2.9
Lincoln County	4 529	6 698.4	2 586.3	.7	1.8
Logan County	17 567	4 762.0	1 838.6	3.7	9.6
Mesa County	93 145	8 619.3	3 327.9	10.8	28.0
Mineral County	558	2 268.4	875.8	.2	.6
Moffat County	11 357	12 283.1	4 742.5	.9	2.4
Montezuma County	18 672	5 275.7	2 036.9	3.5	9.2
Montrose County	24 423	5 803.5	2 240.7	4.2	10.9
Morgan County	21 939	3 329.3	1 285.5	6.6	17.1
Otero County	20 185	3 271.0	1 262.9	6.2	16.0
Ouray County	2 295	1 404.0	542.1	1.6	4.2
Park County	7 174	5 700.1	2 200.8	1.3	3.3
Phillips County	4 189	1 781.0	687.7	2.4	6.1
Pitkin County	12 661	2 513.5	970.5	5.0	13.0
Prowers County	13 347	4 248.9	1 640.5	3.1	8.1
Pueblo County	123 051	6 187.0	2 388.8	19.9	51.5
Rio Blanco County	5 972	8 342.8	3 221.2	.7	1.9
Rio Grande County	10 770	2 363.6	912.6	4.6	11.8
Routt County	14 088	6 117.0	2 361.8	2.3	6.0
Saguache County	4 619	8 206.8	3 168.7	.6	1.5
San Juan County	745	1 003.5	387.4	.7	1.9
San Miguel County	3 653	3 332.2	1 286.6	1.1	2.8
Sedgwick County	2 690	1 420.0	548.3	1.9	4.9
Summit County	12 881	1 575.3	608.2	8.2	21.2
Teller County	12 468	1 442.9	557.1	8.6	22.4
Washington County	4 812	6 529.8	2 521.2	.7	1.9
Weld County	131 821	10 341.3	3 992.8	12.7	33.0
Yuma County	8 954	6 128.3	2 366.1	1.5	3.8
PLACE AND COUNTY SUBDIVISION					
Aguilar town, Las Animas County	520	1.0	.4	520.0	1 300.0
Air Force Academy CDP, El Paso County	9 062	26.0	10.0	348.5	906.2
Akron town, Washington County	1 599	3.4	1.3	470.3	1 230.0
Alamosa city, Alamosa County	7 579	9.0	3.5	842.1	2 165.4
Alamosa East CDP, Alamosa County	1 389	9.7	3.8	143.2	365.5
Alma town, Park County	148	.9	.3	164.4	493.3
Antonito town, Conejos County	875	1.0	.4	875.0	2 187.5
Applewood CDP, Jefferson County	11 069	18.9	7.3	585.7	1 516.3
Arriba town, Lincoln County	220	1.2	.5	183.3	440.0
Arvada city	89 235	57.3	22.1	1 557.3	4 037.8
Adams County	2 347	1.3	.5	1 805.4	4 694.0
Jefferson County	86 888	56.1	21.6	1 548.8	4 022.6
Aspen city, Pitkin County	5 049	5.2	2.0	971.0	2 524.5
Ault town, Weld County	1 107	1.7	.7	651.2	1 581.4
Aurora city	222 103	343.2	132.5	647.2	1 676.2
Adams County	27 747	138.6	53.5	200.2	518.6
Arapahoe County	194 352	202.7	78.3	958.8	2 482.1
Douglas County	4	2.0	.8	2.0	5.0
Avon town, Eagle County	1 798	13.1	5.0	137.3	359.6
Basalt town	1 128	1.7	.6	663.5	1 880.0
Eagle County	1 002	1.2	.4	835.0	2 505.0
Pitkin County	126	.5	.2	252.0	630.0
Battlement Mesa CDP, Garfield County	1 477	20.9	8.1	70.7	182.3
Bayfield town, La Plata County	1 090	2.1	.8	519.0	1 362.5
Bennett town, Adams County	1 757	4.2	1.6	418.3	1 098.1
Berthoud town, Larimer County	2 990	3.1	1.2	964.5	2 491.7
Bethune town, Kit Carson County	173	.4	.2	432.5	865.0
Black Forest CDP, El Paso County	8 143	330.4	127.6	24.6	63.8
Black Hawk town, Gilpin County	227	3.8	1.5	59.7	151.3
PLACE AND COUNTY SUBDIVISION—Con.					
Blanca town, Costilla County	272	4.6	1.8	59.1	151.1
Blue River town, Summit County	440	5.7	2.2	77.2	200.0
Bonanza City town, Saguache County	16	1.1	.4	14.5	40.0
Boone town, Pueblo County	341	1.2	.4	284.2	852.5
Boulder city, Boulder County	83 312	58.4	22.6	1 426.6	3 686.4
Bow Mar town	854	1.8	.7	474.4	1 220.0
Arapahoe County	613	1.1	.4	557.3	1 532.5
Jefferson County	241	.7	.3	344.3	803.3
Branson town, Las Animas County	58	1.9	.7	30.5	82.9
Breckenridge town, Summit County	1 285	11.2	4.3	114.7	298.8
Brighton city	14 203	38.7	15.0	367.0	946.9
Adams County	14 186	37.8	14.6	375.3	971.6
Weld County	17	.9	.3	18.9	56.7
Brookside town, Fremont County	183	1.1	.4	166.4	457.5
Broomfield city	24 638	57.8	22.3	426.3	1 104.8
Adams County	6 722	26.0	10.0	258.5	672.2
Boulder County	16 390	21.5	8.3	762.3	1 974.7
Jefferson County	1 522	7.4	2.8	205.7	543.6
Weld County	4	2.9	1.1	1.4	3.6
Brush city, Morgan County	4 165	6.3	2.4	661.1	1 735.4
Buena Vista town, Chaffee County	1 752	8.7	3.4	201.4	515.3
Burlington city, Kit Carson County	2 941	4.5	1.7	653.6	1 730.0
Byers CDP, Arapahoe County	1 065	11.1	4.3	95.9	247.7
Calhan town, El Paso County	562	1.8	.7	312.2	802.9
Campion CDP, Larimer County	1 692	9.8	3.8	172.7	445.3
Campo town, Baca County	121	.4	.1	302.5	1 210.0
Canon City city, Fremont County	12 687	20.4	7.9	621.9	1 605.9
Carbondale town, Garfield County	3 004	4.3	1.7	698.6	1 767.1
Cascade-Chipita Park CDP, El Paso County	1 479	35.1	13.5	42.1	109.6
Castle Rock city, Douglas County	8 708	79.9	30.9	109.0	281.8
Castlewood CDP, Arapahoe County	24 392	16.2	6.3	1 505.7	3 871.7
Cedaredge town, Delta County	1 380	3.3	1.3	418.2	1 061.5
Center town	1 963	2.1	.8	934.8	2 453.8
Rio Grande County	4	.3	.1	13.3	40.0
Saguache County	1 959	1.7	.7	1 152.4	2 798.6
Central City city, Gilpin County	335	2.3	.9	145.7	372.2
Cheraw town, Otero County	265	.4	.2	662.5	1 325.0
Cherry Hills Village city, Arapahoe County	5 245	16.1	6.2	325.8	846.0
Cheyenne Wells town, Cheyenne County	1 128	2.7	1.0	417.8	1 128.0
Cimarron Hills CDP, El Paso County	11 160	15.5	6.0	720.0	1 860.0
Clifton CDP, Mesa County	12 671	17.9	6.9	707.9	1 836.4
Coal Creek town, Fremont County	157	1.7	.7	92.4	224.3
Cokedale town, Las Animas County	116	.5	.2	232.0	580.0
Collbran town, Mesa County	228	.5	.2	456.0	1 140.0
Colorado City CDP, Pueblo County	1 149	91.2	35.2	12.6	32.6
Colorado Springs city, El Paso County	281 140	474.5	183.2	592.5	1 534.6
Columbine CDP	23 969	16.6	6.4	1 443.9	3 745.2
Arapahoe County	1 572	1.9	.7	827.4	2 245.7
Jefferson County	22 397	14.8	5.7	1 513.3	3 929.3
Columbine Valley town, Arapahoe County	1 071	2.5	1.0	428.4	1 071.0
Commerce City city, Adams County	16 466	51.7	20.0	318.5	823.3
Cortez city, Montezuma County	7 284	13.9	5.4	524.0	1 348.9
Craig city, Moffat County	8 091	12.5	4.8	647.3	1 685.6
Crawford town, Delta County	221	.6	.2	368.3	1 105.0
Creede town, Mineral County	362	1.1	.4	329.1	905.0
Crested Butte town, Gunnison County	878	1.0	.4	878.0	2 195.0
Crestone town, Saguache County	39	.7	.3	55.7	130.0
Cripple Creek city, Teller County	584	2.6	1.0	224.6	584.0
Crook town, Logan County	148	.3	.1	493.3	1 480.0
Crowley town, Crowley County	225	.7	.3	321.4	750.0
Dacono city, Weld County	2 228	4.3	1.7	518.1	1 310.6
De Beque town, Mesa County	257	.8	.3	321.3	856.7
Deer Trail town, Arapahoe County	476	2.4	.9	198.3	528.9
Del Norte town, Rio Grande County	1 674	2.2	.9	760.9	1 860.0
Delta city, Delta County	3 789	7.1	2.8	533.7	1 353.2
Denver city, Denver County	467 610	397.0	153.3	1 177.9	3 050.3
Derby CDP, Adams County	6 043	4.6	1.8	1 313.7	3 357.2
Dillon town, Summit County	553	2.6	1.0	212.7	553.0
Dinosaur town, Moffat County	324	1.8	.7	180.0	462.9
Dolores town, Montezuma County	866	1.6	.6	541.3	1 443.3
Dove Creek town, Dolores County	643	1.4	.5	459.3	1 286.0
Durango city, La Plata County	12 430	12.1	4.7	1 027.3	2 644.7
Eads town, Kiowa County	780	1.2	.5	650.0	1 560.0
Eagle town, Eagle County	1 580	2.3	.9	687.0	1 755.6
Eagle-Vail CDP, Eagle County	1 922	1.7	.6	1 130.6	3 203.3
Eaton town, Weld County	1 959	2.4	.9	816.3	2 176.7
Eckley town, Yuma County	211	1.2	.5	175.8	422.0
Edgewater city, Jefferson County	4 613	1.9	.7	2 427.9	6 590.0
Elizabeth town, Elbert County	818	1.4	.5	584.3	1 636.0
El Jebel CDP, Eagle County	2 605	14.9	5.7	174.8	457.0
Empire town, Clear Creek County	401	.7	.3	572.9	1 336.7
Englewood city, Arapahoe County	29 387	16.9	6.5	1 738.9	4 521.1
Erie town	1 258	9.5	3.7	132.4	340.0
Boulder County	14	3.3	1.3	4.2	10.8
Weld County	1 244	6.2	2.4	200.6	518.3
Estes Park town, Larimer County	3 184	13.2	5.1	241.2	624.3
Evans city, Weld County	5 877	7.0	2.7	839.6	2 176.7
Evergreen CDP, Jefferson County	7 582	26.8	10.4	282.9	729.0
Fairplay town, Park County	387	2.0	.8	193.5	483.8
Federal Heights city, Adams County	9 342	4.7	1.8	1 987.7	5 190.0
Firestone town, Weld County	1 358	2.9	1.1	468.3	1 234.5

Table 16. **Land Area and Population Density: 1990**—Con.

[For definitions of terms and meanings of symbols, see text]

State County Place and [In Selected States] County Subdivision	All persons	Land area: Square kilometers	Land area: Square miles	Persons per—: Square kilometer	Persons per—: Square mile
PLACE AND COUNTY SUBDIVISION—Con.					-
Flagler town, Kit Carson County	564	1.4	.5	402.9	1 128.0
Fleming town, Logan County	344	1.1	.4	312.7	860.0
Florence city, Fremont County	2 990	5.3	2.0	564.2	1 495.0
Fort Carson CDP, El Paso County	11 309	24.3	9.4	465.4	1 203.1
Fort Collins city, Larimer County	87 758	106.7	41.2	822.5	2 130.0
Fort Lupton city, Weld County	5 159	7.5	2.9	687.9	1 779.0
Fort Morgan city, Morgan County	9 068	11.2	4.3	809.6	2 108.8
Fountain city, El Paso County	9 984	36.6	14.1	272.8	708.1
Fowler town, Otero County	1 154	1.0	.4	1 154.0	2 885.0
Fraser town, Grand County	575	3.7	1.4	155.4	410.7
Frederick town, Weld County	988	8.1	3.1	122.0	318.7
Frisco town, Summit County	1 601	3.1	1.2	516.5	1 334.2
Fruita city, Mesa County	4 045	10.5	4.1	385.2	986.6
Fruitvale CDP, Mesa County	5 222	8.2	3.2	636.8	1 631.9
Garden City town, Weld County	199	.3	.1	663.3	1 990.0
Gateway CDP, Douglas County	7 510	13.8	5.3	544.2	1 417.0
Genesee CDP, Jefferson County	2 737	17.2	6.6	159.1	414.7
Genoa town, Lincoln County	167	.9	.3	185.6	556.7
Georgetown town, Clear Creek County	891	1.9	.7	468.9	1 272.9
Gilcrest town, Weld County	1 084	1.8	.7	602.2	1 548.6
Glendale city, Arapahoe County	2 453	1.4	.5	1 752.1	4 906.0
Gleneagle CDP, El Paso County	1 661	3.9	1.5	425.9	1 107.3
Glenwood Springs city, Garfield County	6 561	11.9	4.6	551.3	1 426.3
Golden city, Jefferson County	13 116	19.5	7.5	672.6	1 748.8
Granada town, Prowers County	513	1.8	.7	285.0	732.9
Granby town, Grand County	966	1.7	.7	568.2	1 380.0
Grand Junction city, Mesa County	29 034	38.5	14.8	754.1	1 961.8
Grand Lake town, Grand County	259	2.3	.9	112.6	287.8
Greeley city, Weld County	60 536	73.6	28.4	822.5	2 131.5
Green Mountain Falls town	663	2.2	.8	301.4	828.8
El Paso County	634	1.9	.7	333.7	905.7
Teller County	29	.3	.1	96.7	290.0
Greenwood Village city, Arapahoe County	7 589	20.0	7.7	379.5	985.6
Grover town, Weld County	135	1.3	.5	103.8	270.0
Gunbarrel CDP, Boulder County	9 388	15.9	6.1	590.4	1 539.0
Gunnison city, Gunnison County	4 636	8.2	3.2	565.4	1 448.8
Gypsum town, Eagle County	1 750	4.9	1.9	357.1	921.1
Hartman town, Prowers County	108	.8	.3	135.0	360.0
Haswell town, Kiowa County	62	2.2	.8	28.2	77.5
Haxtun town, Phillips County	952	1.2	.5	793.3	1 904.0
Hayden town, Routt County	1 444	3.7	1.4	390.3	1 031.4
Highlands Ranch CDP, Douglas County	10 181	12.5	4.8	814.5	2 121.0
Hillrose town, Morgan County	169	.6	.2	281.7	845.0
Holly town, Prowers County	877	1.9	.7	461.6	1 252.9
Holyoke city, Phillips County	1 931	4.5	1.7	429.1	1 135.9
Hooper town, Alamosa County	112	.6	.3	186.7	373.3
Hotchkiss town, Delta County	744	1.7	.7	437.6	1 062.9
Hot Sulphur Springs town, Grand County	347	1.7	.7	204.1	495.7
Hudson town, Weld County	918	1.1	.4	834.5	2 295.0
Hugo town, Lincoln County	660	1.4	.6	471.4	1 100.0
Idaho Springs city, Clear Creek County	1 834	2.1	.8	873.3	2 292.5
Ignacio town, La Plata County	720	.6	.2	1 200.0	3 600.0
Iliff town, Logan County	174	.7	.3	248.6	580.0
Jamestown town, Boulder County	251	1.7	.7	147.6	358.6
Johnstown town, Weld County	1 579	1.1	.4	1 435.5	3 947.5
Julesburg town, Sedgwick County	1 295	3.3	1.3	392.4	996.2
Keenesburg town, Weld County	570	1.4	.5	407.1	1 140.0
Ken Caryl CDP, Jefferson County	24 391	24.8	9.6	983.5	2 540.7
Keota town, Weld County	5	.5	.2	10.0	25.0
Kersey town, Weld County	980	.9	.3	1 088.9	3 266.7
Kim town, Las Animas County	76	.8	.3	95.0	253.3
Kiowa town, Elbert County	275	1.1	.4	250.0	687.5
Kit Carson town, Cheyenne County	305	1.4	.6	217.9	508.3
Kremmling town, Grand County	1 166	3.4	1.3	342.9	896.9
Lafayette city, Boulder County	14 548	17.9	6.9	812.7	2 108.4
La Jara town, Conejos County	725	.8	.3	906.3	2 416.7
La Junta city, Otero County	7 637	6.7	2.6	1 139.9	2 937.3
Lake City town, Hinsdale County	223	2.2	.8	101.4	278.8
Lakeside town, Jefferson County	11	.5	.2	22.0	55.0
Lakewood city, Jefferson County	126 481	105.7	40.8	1 196.6	3 100.0
Lamar city, Prowers County	8 343	10.7	4.1	779.7	2 034.9
Larkspur town, Douglas County	232	11.5	4.4	20.2	52.7
La Salle town, Weld County	1 783	1.8	.7	990.6	2 547.1
Las Animas city, Bent County	2 481	3.3	1.3	751.8	1 908.5
La Veta town, Huerfano County	726	2.8	1.1	259.3	660.0
Leadville city, Lake County	2 629	2.7	1.1	973.7	2 390.0
Leadville North CDP, Lake County	1 757	6.6	2.6	266.2	675.8
Limon town, Lincoln County	1 831	4.4	1.7	416.1	1 077.1
Lincoln Park CDP, Fremont County	3 728	9.8	3.8	380.4	981.1
Littleton city	33 685	31.9	12.3	1 056.0	2 738.6
Arapahoe County	33 577	31.4	12.1	1 069.3	2 775.0
Douglas County	108	.5	.2	216.0	540.0
Lochbuie town, Weld County	1 168	1.6	.6	730.0	1 946.7
Log Lane Village town, Morgan County	667	.7	.3	952.9	2 223.3
Longmont city, Boulder County	51 555	34.0	13.1	1 516.3	3 935.5
Louisville city, Boulder County	12 361	19.9	7.7	621.2	1 605.3
Loveland city, Larimer County	37 352	55.4	21.4	674.2	1 745.4
Lyons town, Boulder County	1 227	2.5	1.0	490.8	1 227.0
Manassa town, Conejos County	988	2.4	.9	411.7	1 097.8
Mancos town, Montezuma County	842	1.5	.6	561.3	1 403.3
Manitou Springs city, El Paso County	4 535	7.9	3.0	574.1	1 511.7
Manzanola town, Otero County	437	.7	.3	624.3	1 456.7
Marble town, Gunnison County	64	.8	.3	80.0	213.3
Mead town, Weld County	456	2.5	1.0	182.4	456.0
Meeker town, Rio Blanco County	2 098	7.7	3.0	272.5	699.3

State County Place and [In Selected States] County Subdivision	All persons	Land area: Square kilometers	Land area: Square miles	Persons per—: Square kilometer	Persons per—: Square mile
PLACE AND COUNTY SUBDIVISION—Con.					
Merino town, Logan County	238	.4	.1	595.0	2 380.0
Milliken town, Weld County	1 605	12.4	4.8	129.4	334.4
Minturn town, Eagle County	1 066	3.6	1.4	296.1	761.4
Moffat town, Saguache County	99	3.6	1.4	27.5	70.7
Monte Vista city, Rio Grande County	4 324	4.1	1.6	1 054.6	2 702.5
Montezuma town, Summit County	60	.2	.1	300.0	600.0
Montrose city, Montrose County	8 854	15.1	5.8	586.4	1 526.6
Monument town, El Paso County	1 020	10.6	4.1	96.2	248.8
Morrison town, Jefferson County	465	3.0	1.1	155.0	422.7
Mountain View town, Jefferson County	550	.2	.1	2 750.0	5 500.0
Mount Crested Butte town, Gunnison County	264	4.0	1.5	66.0	176.0
Naturita town, Montrose County	434	1.7	.7	255.3	620.0
Nederland town, Boulder County	1 099	3.6	1.4	305.3	785.0
New Castle town, Garfield County	679	4.6	1.8	147.6	377.2
Niwot CDP, Boulder County	2 666	10.5	4.1	253.9	650.2
Northglenn city	27 195	18.1	7.0	1 502.5	3 885.0
Adams County	27 195	16.5	6.4	1 648.2	4 249.2
Weld County	-	1.5	.6	-	-
Norwood town, San Miguel County	429	.5	.2	858.0	2 145.0
Nucla town, Montrose County	656	1.8	.7	364.4	937.1
Nunn town, Weld County	324	2.5	1.0	129.6	324.0
Oak Creek town, Routt County	673	.8	.3	841.3	2 243.3
Olathe town, Montrose County	1 263	2.5	1.0	505.2	1 263.0
Olney Springs town, Crowley County	340	.6	.2	566.7	1 700.0
Ophir town, San Miguel County	69	.4	.1	172.5	690.0
Orchard City town, Delta County	2 218	29.5	11.4	75.2	194.6
Orchard Mesa CDP, Mesa County	5 977	14.5	5.6	412.2	1 067.3
Ordway town, Crowley County	1 025	2.0	.8	512.5	1 281.3
Otis town, Washington County	451	1.1	.4	410.0	1 127.5
Ouray city, Ouray County	644	2.2	.8	292.7	805.0
Ovid town, Sedgwick County	349	.4	.2	872.5	1 745.0
Pagosa Springs town, Archuleta County	1 207	6.0	2.3	201.2	524.8
Palisade town, Mesa County	1 871	2.1	.8	891.0	2 338.8
Palmer Lake town, El Paso County	1 480	7.8	3.0	189.7	493.3
Paoli town, Phillips County	29	.9	.3	32.2	96.7
Paonia town, Delta County	1 403	2.0	.8	701.5	1 753.8
Parachute town, Garfield County	658	3.0	1.2	219.3	548.3
Parker town, Douglas County	5 450	34.3	13.2	158.9	412.9
Peetz town, Logan County	179	.5	.2	358.0	895.0
Penrose CDP, Fremont County	2 235	23.4	9.0	95.5	248.3
Pierce town, Weld County	823	1.6	.6	514.4	1 371.7
Pitkin town, Gunnison County	53	.7	.3	75.7	176.7
Platteville town, Weld County	1 515	2.3	.9	658.7	1 683.3
Poncha Springs town, Chaffee County	244	2.9	1.1	84.1	221.8
Ponderosa Park CDP, Elbert County	1 640	38.6	14.9	42.5	110.1
Pritchett town, Baca County	153	.6	.2	255.0	765.0
Prospect Heights town, Fremont County	19	-	-	-	-
Pueblo city, Pueblo County	98 640	93.0	35.9	1 060.6	2 747.6
Pueblo West CDP, Pueblo County	4 386	196.1	75.7	22.4	57.9
Ramah town, El Paso County	94	.6	.2	156.7	470.0
Rangely town, Rio Blanco County	2 278	10.4	4.0	219.0	569.5
Raymer town, Weld County	98	1.8	.7	54.4	140.0
Red Cliff town, Eagle County	297	.6	.2	495.0	1 485.0
Redlands CDP, Mesa County	9 355	49.9	19.3	187.5	484.7
Rico town, Dolores County	92	2.0	.8	46.0	115.0
Ridgway town, Ouray County	423	4.5	1.8	94.0	235.0
Rifle city, Garfield County	4 636	10.0	3.9	463.6	1 188.7
Rockvale town, Fremont County	321	1.2	.5	267.5	642.0
Rocky Ford city, Otero County	4 162	4.1	1.6	1 015.1	2 601.3
Romeo town, Conejos County	341	.6	.2	568.3	1 705.0
Rye town, Pueblo County	168	.3	.1	560.0	1 680.0
Saguache town, Saguache County	584	1.0	.4	584.0	1 460.0
Salida city, Chaffee County	4 737	5.7	2.2	831.1	2 153.2
Sanford town, Conejos County	750	3.6	1.4	208.3	535.7
San Luis town, Costilla County	800	1.2	.5	666.7	1 600.0
Sawpit town, San Miguel County	36	.1	-	360.0	-
Security-Widefield CDP, El Paso County	23 822	38.2	14.8	623.6	1 609.6
Sedgwick town, Sedgwick County	183	.9	.3	203.3	610.0
Seibert town, Kit Carson County	181	.8	.3	226.3	603.3
Severance town, Weld County	106	.5	.2	212.0	530.0
Sheridan city, Arapahoe County	4 976	5.7	2.2	873.0	2 261.8
Sheridan Lake town, Kiowa County	95	.8	.3	118.8	316.7
Sherrelwood CDP, Adams County	16 636	6.4	2.5	2 599.4	6 654.4
Silt town, Garfield County	1 095	1.4	.5	782.1	2 190.0
Silver Cliff town, Custer County	322	40.5	15.6	8.0	20.6
Silver Plume town, Clear Creek County	134	.6	.2	223.3	670.0
Silverthorne town, Summit County	1 768	7.9	3.0	223.8	589.3
Silverton town, San Juan County	716	2.0	.8	358.0	895.0
Simla town, Elbert County	481	1.4	.5	343.6	962.0
Snowmass Village town, Pitkin County	1 449	42.6	16.4	34.0	88.4
Southglenn CDP, Arapahoe County	43 087	25.5	9.9	1 689.7	4 352.2
Springfield town, Baca County	1 475	2.1	.8	702.4	1 843.8
Starkville town, Las Animas County	104	.3	.1	346.7	1 040.0
Steamboat Springs city, Routt County	6 695	23.2	9.0	288.6	743.9
Sterling city, Logan County	10 362	14.0	5.4	740.1	1 918.9
Stratmoor CDP, El Paso County	5 854	7.6	2.9	770.3	2 018.6
Stratton town, Kit Carson County	649	1.2	.5	540.8	1 298.0
Sugar City town, Crowley County	252	1.0	.4	252.0	630.0
Superior town	255	9.3	3.6	27.4	70.8
Boulder County	255	8.2	3.2	31.1	79.7
Jefferson County	-	1.0	.4	-	-
Swink town, Otero County	584	.7	.3	834.3	1 946.7
Telluride town, San Miguel County	1 309	1.7	.7	770.0	1 870.0
The Pinery CDP, Douglas County	4 885	14.2	5.5	344.0	888.2

PROJECT FILE

FILE NAME GENERAL SITE CHARACTERIZATION **JOB NUMBER** 41861.30 **FILE NUMBER** .5

TASK BURLINGTON NORTHERN FUELING SITE - MISSOULA, MISSOULA, MONATANA

SITE MANAGER BARRY HAYHURST

URS

URS CONSULTANTS, INC.
1099 18TH STREET, SUITE #700
DENVER, COLORADO 80202-1907